

UGANDA PROTECTORATE.

ANNUAL REPORT

OF THE

DEPARTMENT OF AGRICULTURE

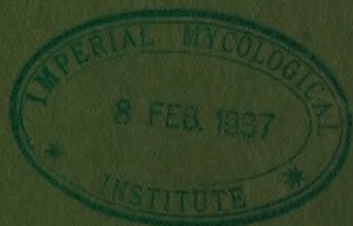
FOR THE

YEAR ENDED 30TH JUNE, 1936.

(PART II).

PRICE: SHS. 5.

Published by Command of His Excellency the Governor.



ENTEBBE:

PRINTED BY THE GOVERNMENT PRINTER, UGANDA.

1936.

UGANDA PROTECTORATE.

ANNUAL REPORT

OF THE

DEPARTMENT OF AGRICULTURE

FOR THE

YEAR ENDED 30TH JUNE, 1936.

(PART II).

Published by Command of His Excellency the Governor.



ENTEBBE:

PRINTED BY THE GOVERNMENT PRINTER, UGANDA.

1936.

CONTENTS.

	PAGE.
Introduction	5-7
Report of the Government Entomologist	8-11
Report of the Assistant Entomologist	12-18
Pink Bollworm Report	19-39
Report of the Mycologist	40-42
Blackarm Research Report	43-48
Report of the Agricultural Chemist	49-55
Report of the Botanical Section	56-92
Botanical Work, Kampala	57-65
The Botanic Gardens, Entebbe	66-68
Botanical Work, Bukalasa	69-79
Botanical Work, Serere	80-92
Annual Report on the Experimental Work done in the Northern Province	93-96
Report on Bukalasa Experiment Station	97-102
Annual Report on Experimental Work done in the Eastern Province	103-113
Appendices	114-123

INDEX.

	PAGE.		PAGE.
<i>Abroma augusta</i>	63	<i>Eleusine</i>	91
Antestia	9-10	Erosion	49-50
Bananas	65	Erosion, Experiment, Serere	112
Beekeeping	8-9	Exhaustion Experiment	96
Blackarm	43-48	Essential Oils, Cultivation	61-62
Castor Oil Selections	63	Essential Oils, Distillation	55
Cassava, Analysis	54-55	Fibres	54
Cassava, Variety Trial	111	Fruit	67
Cassava Collection	79	Ginger	79
Chillies	63	Grasses	64, 95
Citrus	65	Green Manures	64
Coffee, <i>Arabica</i> .—		Green Manure, Experiment on Cotton	98
Pruning Experiment, Kampala	59-60	Groundnuts, Variety Trials	100, 104
Pruning Experiments, Bugusege	107-108	Groundnuts, Mulching Experiment	104
Cultural Experiments, Bugusege	108-109	Groundnuts, Selections	91
Spacing Experiment, Bugusege	109	<i>Helopeltis</i> , on Cotton	18
Shade Experiment, Bugusege	109-110	<i>Helopeltis</i> , on Tea	11
Shade Experiment, West Nile, N.P.	94	<i>Helopeltis</i> , Influence of Soils on	52
Varieties	65	<i>Hydnocarpus</i>	66
Coffee, <i>Robusta</i> .—		Interplanting	98, 105
Shade and Cover Crop Experiment	100-101	Jassids	12-15
Ground Treatment, Experiment	101	Locusts	8
Shade and Ground Treatment, Experiment	101	<i>Lygus</i>	16-17
Ground Treatment	59	Manila Hemp	63
Pruning Experiment	59-60	Manurial Experiments	50, 95-96, 111-112
Selection	57-58	Model Shamba	102
Breeding	58	Oil Palm	62-63, 66, 111
Vegetative Propagation	59	Pepper	67
Coffee, Wild	61	Pink Bollworm	19
Compost	51	<i>Plaesius javanus</i>	11
Cotton:—		Prorops	10
Brokers' Reports	76, 89-90	Ramie	111
Mound and Ridge Cultivation	106-107	Rotation Experiments	99, 112-113
Hybrids	71, 82-83	Regeneration Experiments	96, 112
Increase Plots	71, 88-89	Shea Nuts	91
Pests and Diseases	78-79	Sim-sim, Admixture	55
Selection	57-58, 69-70	Sim-sim, Selection	79
Spacing Tests	75-76, 83-85	Soils, Analysis	52-54
Sowing Date Trials	83-85, 94, 105-106	Sorghum	91
Sowing Date Trial (Isolated)	87-88	Stainers	15-16
Spinning Tests	76-78, 89-90	Sugar Cane Varieties	63-64
Seed Farms	79	Sweet Potatoes, Variety Trial	99-100
Segregated Areas	88-89	Tea	61, 67
Samples	78	Tobacco	79, 92, 110
Variety Trials	71-76, 83-85	Vanilla	63
Quarter Acre Comparisons	86-87	Weather	66, 69, 80
Mulching Experiment	93, 98, 106		
Two Plants per Hole Experiment	98		
Topping Experiment	99		

INTRODUCTION.

While Part I of the Annual Report covers the calendar year, this one, called Part II, relates to the year ending on June 30th, 1936.

2. This report is always difficult to present in readable form as much of it is technical and of interest primarily to research workers. Dry, uninteresting and colourless as it may seem, however, the report contains a great deal of information that is of vital importance to Uganda and I make no apology for its appearance. Attention may be drawn to some of the more important matters referred to in this progress report.

3. COTTON.—The cotton breeding work has been pursued actively at both Bukalasa and Serere and at the former station has received a disappointing set-back. A pure strain known as B.P. 50 had been produced that was a great improvement on local cotton and was ready for the early stage of multiplication a year ago. It went down badly, however, to Wilt disease and as this disease has increased a good deal in recent years, it was considered unwise to go on with B.P. 50, unless a strain can be isolated from it that is resistant to Wilt.

As it will be impossible to produce a pure improved strain for Buganda in the immediate future, arrangements have been made to bridge the gap with mass selections from a number of good strains. At Serere, further improvements have been made with the U. 4 strains originally received from Barberton. These strains were short and harsh but resistant to Blackarm disease, Jassid attack, and drought, and had a high ginning out-turn. They have been improved very greatly at Serere, the lint length having been increased and the harshness removed while at the same time there has been preserved in a large measure the resistance to Blackarm disease, to Jassid attack, and to drought and the high ginning out-turn. As in Buganda, in addition to the breeding of pure lines, arrangements have been made to do mass selection work with a view to having something available for rapid distribution, in case, for some unforeseen reason, a safe pure line is not available when required.

4. COFFEE (*Robusta*).—The Assistant Botanist, Mr. A. S. Thomas, visited the Imatong mountains in the Southern Sudan and brought back some seed selected from promising types of wild *Robusta* coffee. Special interest attaches to this, in that the Imatong mountains are considerably drier than most of Uganda's coffee areas and a type of coffee is required that will stand the comparatively dry climates of Ankole and Kigezi. The selection work on what are called the Nganda or spreading type of *Robusta* coffees, so frequently seen in native gardens in Buganda, is also proceeding satisfactorily. Some of the Bukalasa experiments are reaching an interesting stage. Permanent cover crops and permanent weed cover are both shown to have a highly depressing effect on coffee yields, and clean weeding or mulching are shown to be superior. As mulching not only supplies food materials but also prevents erosion, it is proving in practice to be an exceptionally satisfactory ground treatment.

5. COFFEE (*Arabica*).—The main experiments are at Bugusege and a few experiments are discussed under the caption "Botanical Work", Kampala. An interesting point emerging is that the single stem method of pruning does not give as good yields under Uganda conditions as either the Agobiada, or what we call the modified multiple stem system that was designed primarily for Bugishu. A combination that is giving satisfactory results is the modified multiple system of pruning with banana leaf mulch. Another ground treatment not yet fully tested, but which has given excellent results so far, is a cover crop of beans for the period March to October and clean weeded for the balance of the year. It remains to be seen to what extent erosion takes place under this system.

6. **GROUNDNUTS.**—Selection work is proceeding at Serere and experiments to test various points have been conducted; from a practical point of view, an interesting development is that experiments are tending to show that cotton interplanted with one row of groundnuts gives a considerably better cash return than cotton alone. In the event of this being confirmed by repetitions of the experiments, it would be possible to increase greatly the quantity of groundnuts grown in the Protectorate without diminishing the cotton acreage. Single rows of groundnuts are apt to go down with Mosaic disease, and two rows, although less subject to Mosaic are apt to depress the cotton yield. Difficulties such as these would have to be overcome before the practice could be made general, but the results obtained to date indicate that this is a very promising field for further research.

7. **TOBACCO.**—Selection work is proceeding slowly and plots of tobacco have been grown at various places in the Protectorate so as to enable a decision to be made when the time comes as to where to extend tobacco growing as a native crop when saturation is reached in the West Nile and Bunyoro Districts.

8. **NATIVE FOOD CROPS.**—At various places in the report, reference will be found to experimental work being done with native food crops. This work receives rather scant attention in reports, but, in fact, the work is as important as any done by the Department and a great deal of time is devoted to it at the various experimental stations. It is impossible to refer to this work in detail and I will refer only to the "Cassava" variety trial. While this, from a dietary point of view, is not a protective food, yet from a famine prevention point of view, it may prove to be a highly important food plant in Uganda in time of partial food shortage. Mosaic disease has been one of the difficulties and there are in the trial nine varieties more or less resistant to the disease. A striking result of the trial is that the local variety yielded only 2·4 tons per acre as against 11·3 tons in the case of "Bobby Hanson" which is a more recently introduced variety.

9. **ENTOMOLOGY.**—More space is devoted in this report to entomology than is customary, this being due in part to there being an extra Assistant Entomologist on the staff which has enabled one officer to be posted to Serere. There are three items to which it seems desirable to call particular attention in this introduction. In the first place, the third and perhaps final shipment has been received from Java of the beetle *Plaesus javanus* that feeds upon the banana weevil. This weevil has been spreading slowly in the Protectorate and has the reputation of being one of the worst insect pests known on bananas. In view of the importance of bananas in Uganda from a native food point of view, steps were taken some years ago to introduce *Plaesus* in order to check the ravages of the weevil. It is hoped that the introductions now made may be sufficient to enable this useful insect to become established. Secondly, attention is drawn to the excellent beginning that has been made at Serere toward a detailed study of the major insect pests of cotton in the Eastern Province. As will be seen from the report this work is done in the closest co-operation with that of other officers at Serere and is, in fact, a good example of effective team work. In the third place, attention is invited to the satisfactory report on the Pink Bollworm. This insect has been extending its range over Uganda since 1930, or before, and it was impossible to forecast how important a pest it might become under Uganda conditions. In many cotton growing countries, it is a major pest and a factor to be reckoned with in drawing up the budget. Mr. Taylor has devoted all his time to a study of this pest and as a preliminary step visited Egypt and the Sudan to study the position and remedies adopted in those countries. The work is not finished but has gone far enough to enable it to be said that the position is reassuring and that it is unlikely that expensive or particularly irksome measures of control will become necessary. It is of interest to note that the close season for cotton growing introduced many years ago on the advice of Mr. Simpson is, in fact, one of the best methods of controlling the Pink Bollworm that could be devised under Uganda conditions.

10. **MYCOLOGY.**—While the Blackarm disease studies were continued at Serere through the co-operation of the Assistant Botanist—another example of good team work—the main interest this year centres in the report on the Cotton

Wilt disease position. As mentioned earlier, the most promising of all the pure lines developed at Bukalasa, a strain numbered B.P. 50, was attacked badly with Wilt disease and this has disturbed seriously the entire cotton breeding programme at Bukalasa. The disease is not new to Uganda but in recent years appears to have been increasing both in distribution and severity. The report gives a clear picture of the nature of this disease and indicates that the breeding of resistant strains is likely to prove the simplest method of control.

11. SOIL CHEMISTRY.—The report of the Agricultural Chemist is of particular interest this year. In view of the soil deterioration known to be taking place in Teso and other parts of the Eastern Province, Dr. Martin has been stationed at Serere in order to study at first hand the processes that are involved and to act as scientific adviser to the group of various officials that have been set up as a team to deal with them. As there is no Chemical Laboratory at Serere, the work, so far, has consisted largely of field and observation work and the devising and laying down of experiments designed to answer the questions involved. The report deals very largely, therefore, with soil deterioration questions and with the cognate problems of how to make good “kraal” manure under Uganda conditions and how to make better use than we do of surplus cotton seed. It is stated in the report that we are now exporting annually in cotton seed something like 2,700 tons of nitrogen, 1,000 tons of phosphoric acid and 860 tons of potash. These are important tonnages and it is clear that ways and means should be found, if possible, of keeping these ingredients in the country. It has also been pointed out elsewhere by Mr. Hosking that the nitrogen lost annually through burning the uprooted cotton trees represents a substantial tonnage.

12. Acknowledgments have been made throughout the report to many people and institutions who have in one way or another given assistance to the Officers concerned. To these kindly people and to others not specifically mentioned I can only say that their assistance is very much appreciated. I wish also to take this opportunity of expressing my appreciation to Members of the Experimental Committee of the Coffee Board for the assistance they have given in connection with coffee experiments.

J. D. TOTHILL,

Director of Agriculture.

REPORT OF THE GOVERNMENT ENTOMOLOGIST FOR 1935.

The Government Entomologist returned from leave late in January. Mr. Taylor, Assistant Entomologist, appointed for special work on Pink Bollworm, reached Uganda *via* Egypt and the Sudan late in February. Mr. Hopkins, Entomologist, proceeded on leave on June 6th consequent on prolonged illness. Mr. Gwynn arrived at the end of July on first appointment as Assistant Entomologist, replacing Mr. Hancock whose transfer from the section had been effected on January 1st.

As a result of the illness of the Entomologist, the Government Entomologist expended much of his time on medical entomological work and this, coupled with the demands of administrative duties, allowed little time for work on agricultural entomology. The report on medical entomological work will be published in that of the Medical Department.

Mr. Taylor has spent his time entirely on Pink Bollworm investigations; a special report on the first full season's work has been submitted to Government.

Mr. Gwynn was stationed at Serere Experiment Station and his time has been applied entirely to the study of cotton insects. His report is appended. Om. H. D. Mubiru, African Agricultural Assistant, was also stationed at Serere for six months and assisted with the cotton insect investigations.

Mr. Chorley, Laboratory Assistant, was engaged mainly on medical entomological work; on the agricultural side, he carried out experiments and extension work in connection with bee-keeping, his experience and keen interest specially qualifying him for such duties.

This report is divided into the following sections: Locusts, Beekeeping, Experimental, Advisory, Tea, Miscellaneous.

LOCUSTS.

The locust infestation continued throughout the year.

Very few swarms of the Tropical Migratory Locust (*Locusta*) were observed and these were not seen after February, 1935.

The egg-laying by Red Locust (*Nomadacris*) which occurred late in 1934 produced a few small and scattered hopper bands in January but these, as a result of control by local inhabitants, assisted by birds, failed to give rise to any swarm. During July, an influx of swarms occurred across the southern border of the Protectorate, Kigezi, Ankole, Toro and Masaka Districts being affected, the last two but slightly. Later (September and October) the infestation was confined to Ankole. During November no locusts were reported from any district; the rainy conditions seemed to have dispersed the swarms which apparently did not reform.

Further swarms of *Nomadacris* entered from the south in December and spread over the south-eastern Ankole and south-western Masaka Districts. No further egg-laying had been observed at the end of the year.

For the information of surrounding territories and of the Imperial Institute of Entomology, reports, and maps showing distribution of locusts, have been compiled each month.

Some small damage was caused to banana, millet, maize, beans, groundnuts, wheat, sugar-cane, cotton and Eucalyptus in three districts of the four invaded.

It would appear that some climatic factor renders the greater part of Uganda unfavourable to the continued existence of *Nomadacris* in dangerous numbers, and that any serious infestation by this species, such as was experienced in the case of *Locusta* during 1931—1934, will not occur.

BEEKEEPING.

The efforts to establish a beekeeping industry among natives have been sustained and encouraging progress has been made in favourable districts, particularly Kigezi which is by far the most promising area so far dealt with. Demonstrations of the extraction and preparation of wax were given at a number of native administrative centres in Ankole and Kigezi, and natives in both districts have commenced to extract and sell their wax. During 1935, 450 lbs.

and 170 lbs. of wax were bought by Government in Kigezi and Ankole respectively, the object being to encourage the producer with a fair cash return for his labour and at the same time to obtain large samples for testing the market.

Propaganda has also been carried out with the assistance of the Agricultural Officers in Toro and Masaka Districts and in Buruli and Bugerere Counties of Mengo. A beekeeping exhibit was staged and demonstrations of wax preparation were given at the Masaka Agricultural Show.

A total of eight natives were trained as instructors: two each for the native administrations of Kigezi and Ankole and one each for the other four areas mentioned above.

Extensive damage was caused early in the year in Ankole owing to the destruction of hives by animals reputed to be civet cat or leopard, but which proved to be the honey-ratel, a type of badger. This animal has given some trouble also in Bugerere and Buruli. A possible solution of this difficulty in districts where suitable tall trees for suspension of hives are scarce, is to surround communal groups of hives with fences of sisal or other material and to set traps for the animal at the entrances.

EXPERIMENTAL.

Experiments were carried out to produce a denser smoke than that obtained from dry cow dung or grass, for facilitating the collection of *Antestia* bug on coffee. Chunks of dried cow dung impregnated with either discarded petrol engine sump oil or cotton seed "tar" both gave very dense smoke.

Tests were made with kerosene extract of pyrethrum on a number of estates to determine the efficacy of arsenite spray bait which was being employed by several planters for control of coffee bug. The results in all cases where the baiting had been carefully done showed a very great reduction of the infestation; this was also indicated by the figures obtained from hand-collection before and after baiting. It is of interest to record that, in the same area at the time of these tests, eggs, and nymphs younger than 4th instar, were, in general, very rare (the large majority of bugs being adult); this observation, coupled with the fact that the coffee berries were of an age when the seeds are hard and unlikely to afford much sustenance for the bug, supports the conclusion, previously reached in feeding experiments by the writer, that *Antestia* requires berry food to enable the female to produce eggs. The results show also that baiting can be successful in the presence of crop if the coffee beans are in a hard condition (about four months old) at which stage it does not act as a counter-attractant.

Further observations were made on the bionomics of *Dirphya princeps* (stem-borer of coffee) which becomes prevalent annually in March and April. A large Braconid parasite of the larva, *Bathyaulax* sp., became common towards the end of the period.

Another series of individual tree observations was made on the plot of coffee grown to test effects of various methods of planting.

Tests were made of various meshes of wire gauze, including bronze, brass, and stainless steel (samples of the last named being kindly provided by the makers), for use in cages required for testing the relative "resistance" of cotton trains against Jassid bugs. It was found that a stainless steel gauze of 24 mesh and 0.01 inch wire was the maximum size which would retain the smallest adults.

ADVISORY.

Advice was sought and given on the following:—

(a) Termites.

1. *Attacking Seedling Canes.*—The affected areas were those which had only partially germinated before the advent of a longish period of dry weather; the damaged setts in many instances were suffering from "Pineapple" disease, and this, in combination with dry weather, was the factor predisposing the cane to attack. Other areas of slightly earlier plantings, which had the advantage of more rain, were scarcely affected.

2. *Eating Roots of Antirrhinum.*—Plants were a year old, suffering from root-disease and grown in poor soil.

(b) Coffee Insects.

1. Mealy-bug on native grown *Robusta* and *Arabica* attended by hordes of ants. Constant clean-weeding had been practised and the soil hilled around the collar—both of which appear to be factors predisposing to attack.

2. *Bixadus sierricola* in stems of *Robusta*.

3. *Antestia lineaticollis*, regarding arsenite spray-baiting and kerosene-pyrethrum spraying.
4. *Metadrepiana marantica* on both coffee species.

5. *Habrochila ? placida*, Horv.—Instances occurred where attack was localised on trees over small areas throughout the period of observation. In one case an attempt had been made to get rid of this lace-wing bug by cutting down the trees, but the bug reappeared and continued to affect only those trees. In a second case the bug continued to infest some 60 trees at the corner of a square block and did not infest trees growing under apparently identical conditions of shade and cultivation across a track four yards wide (a similar instance occurred on a Government Plantation). There would appear to be some special attraction in the sap of certain trees which renders them liable to serious infestation. A Capsid bug *Opistocylus* sp., which in both nymph and adult stages preys on the pest and which in the adult stage and in life bears a strong resemblance to the lace-wing bug, is an important factor in the natural control of the Tingid bug.

In other instances, moderately intense infestation has been general over certain estates and it seems likely that artificial control may become necessary in the near future. Pyrethrum dust, a good quality of which is now procurable at a reasonable price, will probably prove efficient and it is intended to test this insecticide during 1936.

6. *Lycidocoris mimeticus* (Capsid bug) on young coffee under dense shade. As previously pointed out shade is usually the determining factor of attack.

7. *Stephanoderes hampei*.—In one case the falling to the ground among mulch of part of the previous season's very heavy crop, coupled with too dense shade was responsible for a severe outbreak which finally was controlled, after shade reduction, by the parasites of the beetle.

The introduction of *Prorops* from Kampala into Bwamba County of Toro, where the parasite appeared not to occur naturally, was followed by a very marked decrease in 1935 of this berry-borer on the three Native Government *Robusta* plantations where the introduction was effected in 1932. The parasite appears not to spread unassisted to isolated coffee areas in Bwamba and arrangements were made to introduce the parasite to other plantations where damage continued to be severe.

It is of interest to record here that *S. hampei* was found, together with four other *Stephanoderes* spp., in the field in seed of *Phaseolus lunatus* (Identification by Eggers).

8. *Ants*.—The small, black, fierce, leaf-nesting ant, *Macromischoides aculeatus*, Mayr. var., in some areas, particularly where the coffee is allowed free multiple stem growth and a forest-like condition has resulted, is a pest because the ant prevents picking of the crop. It may be controlled by spraying with kerosene-pyrethrum extract, or pyrethrum dust, which should be applied during the dry season to prevent the production of winged individuals and consequent new "nests" which would occur shortly after the advent of rains. The nests should at the same time be destroyed by crushing or burning to ensure death of the immature stages of the ant.

The larger, reddish-brown ant, *Oecophylla smaragdina*, sub-sp. *longinoda*, Latr., occasionally has caused similar trouble. The same action should be taken.

It is probable that such ants play an important part in the control of *Antestia* which ceases to be a pest in older plantations, particularly where the coffee trees are grown with multiple stem and where a canopy of foliage exists and produces forest-like conditions. If this be so, it is an interesting case of beneficial insects becoming pests.

(c) Sap-feeding ants.

These caused severe damage to the bark of "musizi" (*Macropsis*) trees in a forestry plantation. The ant nested in the soil near the tree bases. One part of the area had been constantly clean-weeded for a few months for intergrowth of cotton while the other part had had a cover of weeds during most of period of tree growth; trees in this latter area were not affected and the advised abandonment of clean-weeding in the remainder resulted finally in preventing damage to the trees.

(d) Miscellaneous.

Cylas weevils and *Acraea* caterpillars on sweet potato. *Lasioderma* beetles in tobacco factory. Mites on fowls. *Gryllus africanus* (cricket) on vegetables. Aphid on turnip, *Orthezia insignis* (scale) on *Duranta* and *Gerbera*. *Megalognatha* beetles on flowers of avocado (causing almost complete removal of flowers), and on tassels and young cobs of maize. *Dysdercus* on hollyhock. *Euxoa longidentifera* (cutworm) on young cotton plants and *Porthesia producta* caterpillars defoliating cotton. Beekeeping; twelve bee-nuisances in permanent buildings were also dealt with.

TEA.

This crop continued free from serious damage by insects. *Helopeltis bergrothi* was discovered early in September causing some damage to young transplants in the field. At this stage it was a simple matter to collect and crush the insects whose presence was easily determinable by the spots on the leaves. As an alternative, arsenite spray-baiting was advised; this latter method cannot, however, be employed for tea which is being plucked, and in such cases pyrethrum dusting is recommended by the writer.

On another estate *Helopeltis maynei*, Ghesq. var., was found associated with the typical damage to leaves of seed-bearing trees. This blackish species had been found earlier breeding on *Fuchsia* in the same district.

Aphid was observed to cause severe curling of foliage and stunted growth of nursery plants growing under dense shade. The insect was not prevalent on tea in the field.

MISCELLANEOUS.

Plaesius javanus.—The third and final lot of the series of importations of this predator of the banana weevil, numbering 845 beetles was received at the end of May; only 83 were alive on arrival and of these, 27 survived the quarantine period. Like the previous lot the beetles were fed on larvae of *Oryctes* sp., obtained from heaps of rotting grass. The survivors were liberated early in July on Kibibi Isle at the same place as the earlier introductions.

Conference.—The Government Entomologist and Mr. Taylor attended the meetings of the Uganda Planters' Conference in December. A paper on control of insect pests by parasites was prepared and read by Mr. Taylor.

Visits to Non-Native Estates.—Sixteen coffee and two sugar estates were visited for the investigation of injurious insects.

Plant Importations.—A total of 153 packages of living plant material were inspected during the year.

Visiting Entomologists.—The late Mr. Ritchie of Tanganyika Territory visited the laboratory on four occasions and discussed with the writer insect problems of mutual interest.

Mr. Notley, Entomologist, Kenya, worked at the laboratory during October and November. His studies concerned *Pseudococcus kenyae* (lately known as *Ps. lilacinus*) and factors preventing this mealy-bug being normally a serious pest on coffee in Uganda as it is in Kenya.

Mr. J. P. da Fonseca of Brazil arrived in February and paid many visits to the laboratory during the following four months. The object of his visit was the study of parasites of the coffee berry-borer (*S. hampei*); he was joined in May by his colleague Prof. Dr. Toledo who studied *Heterospilus coffeicola*, parasite of the berry-borer.

Mr. Sladden of the Belgian Congo discussed coffee pests with the writer.

ACKNOWLEDGMENTS.

The Imperial Institute of Entomology has continued to render most valuable assistance.

In addition to those on the staff of the Institute, the following systematists have afforded assistance by naming insects of their special groups:—

G. Arnold, J. Balfour-Browne, M. Banninger, H. F. Barnes, G. A. H. Bedford, H. C. Blote, S. Breuning, E. B. Britton, W. E. China, G. H. Corbett, F. W. Edwards, H. Eggers, E. O. Engel, E. Franz, W. D. Funkhouser, W. J. Hall, M. Hering, G. J. Lockly, H. Priesner, A. Reichardt, H. Scott, J. A. Simes, F. Spaeth, G. B. Thompson.

PUBLICATIONS.

H. HARGREAVES.—“*Stephanoderes hampei*, Ferr., Coffee Berry-Borer in Uganda.” *East African Agric. Journal*, I, pp. 218—224 (1935).

T. W. CHORLEY.—“Beeswax Production and Placing of Beehives.” *Circular No. 23, Dept. of Agric., Uganda*; in English, Luganda and Kiswahili (translations by staff of Education Department), one illustration.

H. HARGREAVES,
Government Entomologist.

REPORT OF ASSISTANT ENTOMOLOGIST.

This section refers only to the Eastern Province and Lango, and only to the period from August 14th, when the writer arrived at Serere, to the end of the cotton season. Attention was mainly confined to *Lygus*, Jassid, and Stainers (*Dysdercus* spp.).

JASSIDS.

Incidence.—At Serere the Jassid population on cotton was consistently very low till October when it began to increase. The maximum population was reached in November, the highest recorded figure being 400 nymphs on a sample of 50 plants (500 leaves). The highest figure for a single plant (10 leaves) was 42 nymphs. The population declined during the middle of December as the cotton began to dry up, and remained at a relatively low figure till the end of the season.

The recorded population is, of course, nothing like as high as that mentioned as causing severe damage at Barberton. In fact, the infestation at Serere this year was neither sufficiently intense nor sufficiently prolonged to cause damage even to the most susceptible varieties. However, the maximum population was associated with a considerable amount of leaf-reddening of the type usually associated with Jassids; the varieties with the highest Jassid population showed considerably more leaf-reddening than other varieties, also the blocks with high Jassid population showed more reddening than blocks with a lower population, irrespective of variety. Two observations having a bearing on the connection between Jassid population and leaf-reddening may be quoted:—

(i) At the peak of the Jassid population it was found that there were big differences in the Jassid population on the different blocks of the Serere Combined Spacing—Sowing Date—Variety Trial. Without reference to the figures, notes were made on the degree of leaf-reddening shown by six plots of S.P. 72 (the most susceptible variety in the trial) with the following result:—

Plot No.	Amount of Reddening.						Jassid Nymphs on 500 Leaves.
56	...	...	...	Some	...	...	69
62	...	...	...	Some	...	...	68
72	...	...	More than in plots 56 and 62			...	204
91	...	...	...	Most reddening	...	...	383
147	...	...	...	Little reddening	...	...	92
254	...	...	...	As Plot 72	...	...	292

The amount of reddening was judged by eye, looking at each plot as a whole; this was done three weeks after the nymph count. For discussion of the nature of the difference between plots, see under *Lygus*.

(ii) When the Variety Trial at Kumi was visited in December there were very few Jassids but there was much physiological leaf-reddening of a type closely resembling that associated with Jassid attack. The interesting point was that all three varieties (S.G. 29, S.P. 72, and S.P. 20) showed approximately the same amount of reddening. At the time it appeared to the writer that S.P. 20 showed slightly less reddening than the other varieties, but on returning to Serere it was found that, plotting the varieties on this assumption, some of them were wrong. The conclusion indicated seems to be that in the absence of a high Jassid population all three varieties (one susceptible to Jassid, two resistant) react about equally to the conditions which are supposed to cause 'Jassid attack'.

Other Centres.—More or less reliable Jassid counts were done at intervals through the season by the Cotton Observers at three of the District Variety Trials. Towards the end of the season counts were received from Observers at most of the other District Variety Trials as well.

All these counts, as well as those made when the plots were visited by the writer, were uniformly low. When the Jassid population at Serere was approaching its peak, the Variety Trial at Nyiro was reported to be heavily infested; however, when visited by the writer some days later the infestation had completely disappeared, as the plants were drying up, so no figures are available as to the size of the population. The only other report of Jassid infestation received was at the end of the season, when the Variety Trials in North Teso were stated to be showing much leaf-reddening, perhaps due to Jassids.

Jassid Nymph Counts on Experiments.—A considerable amount of information as to the relative infestation of different varieties was obtained by nymph counts on the variety trials at Serere, and on the District Variety Trials. In all cases the basis of counting was the number of nymphs on ten leaves on each plant counted. It is considered that more satisfactory results would be obtained by counting only five leaves per plant on selected plants (instead of counting complete rows as hitherto), as this would give a more even sample and greater accuracy; it is intended to adopt this method during the coming season.

(i) *Combined Spacing—Sowing Date—Variety Trial.*—Nymph counts were done on this trial once a month. The figures for the three months with the highest populations are tabulated below (3 × 1 spacings only):—

TABLE I.—VARIETIES × TIME OF COUNTING.
AVERAGE COUNT PER SAMPLE OF 50 PLANTS.

			October.	November.	December.	Nov. and Dec., Combined average.
S.G. 29	..	..	25.3	52.4	18.5	36.9
S.P. 72	..	..	40.8	185.1	27.4	108.3
S.P. 20	..	..	26.9	59.8	16.2	39.0
S.P. 43	..	..	26.2	74.3	18.7	48.2
S.P. 48	..	..	21.9	70.2	17.9	45.5
S.P. 56	..	..	28.3	89.7	27.6	61.6
L.S.D.	..	..	No significance	61.4	5.7	18.4

October figures not included in combined analysis owing to error due to differences between observers.

TABLE II.—SOWING DATES × TIME OF COUNTING.
AVERAGE COUNT PER SAMPLE OF 50 PLANTS.

Sowing Date.					October.	November.	December.
May	..	..	..	..	48.4	(41.8)*	10.4
June	..	..	..	..	14.0	68.4	13.2
July	..	..	..	..	20.0	81.8	21.5
August	..	..	..	..	30.6	114.9	39.1
L.S.D.	..	..	..	..	10.6	No significance	4.7

* Figures for three blocks only: not included in statistical analysis.

It is seen from Table I that in November, when the Jassid infestation was at its peak, the population on S.P. 72 was significantly very much greater than on all other varieties, while in December it is equal to S.P. 56, and both are much greater than the remaining varieties. It should be noted that in the combined analysis for November and December the Interaction Variety × Time of Counting is significant, the L.S.D. being 26.0. It follows from this that when the two months are considered together, in addition to the results already noted, S.P. 56 in November has a significantly higher population than S.P. 20 and S.G. 29.

As regards Table II, the difference between July and August sown cotton in October is believed to be almost entirely due to differences between observers: however, the difference between May and the later sowing dates is very much greater than can be accounted for in this way. Hence we are justified in saying that while in October the earliest sown cotton had a much higher Jassid population *per leaf*, in the later months this order was reversed, the latest sown cotton having the highest population. This result was to be expected on general grounds, as the earlier sown cotton began to dry up first.

(ii) *Miniature Variety Trial.*—The following table gives the results of a count done at the end of November. It is interesting to note the high degree of uniformity within each family group.

TABLE III.

Variety.				Nymphs on 20 plants.	Origin of Variety.
S.G. 29	..	..	..	12.6	Selection from S.G. 29 probable hybrid.
S.P. 89	..	..	..	12.6	
S.P. 72	..	..	..	24.7	Nariama family.
S.P. 88	..	..	..	24.7	
U. 4/4	..	..	..	19.1	
S.P. 1	..	..	..	15.9	Selection from U. 4/4/2.
S.P. 13	..	..	..	14.9	Selected from S.P. 1 through S.P. 13.
S.P. 20	..	..	..	13.8	
S.P. 48	..	..	..	15.4	
S.P. 84	..	..	..	18.1	
S.P. 56	..	..	..	23.5	Selected from S.P. 1 through S.P. 14.
S.P. 86	..	..	..	20.9	
S.P. 87	..	..	..	31.3	
L.S.D.	..	..	..	7.4	

(iii) *District Variety Trials.*—The counts in the following table were done when these trials were visited by the writer in the months indicated.

TABLE IV.—AVERAGE COUNT PER SAMPLE OF 20 PLANTS.

(a) *Five Counts done in September.*

Centre.	N. 17.	S.G. 29.	S.P. 72.	S.P. 20.	L.S.D.	Average at each Centre.
Serere ..	3.5	3.5	6.2	2.5	—	3.9
Nyiro ..	38.0	23.0	40.2	24.5	—	31.4
Kachumbala ..	17.2	18.2	18.2	12.5	—	16.6
Kibale ..	13.0	12.0	18.5	10.7	5.5	13.6
Mulanda ..	8.7	6.7	8.5	7.2	—	7.8
TOTALS ..	80.5	63.5	91.7	57.5	17.7	—

Conclusion:—S.P. 72 $\triangleright$ S.G. 29 = S.P. 20.

S.P. 72 = N. 17 $\triangleright$ S.P. 20.

(b) *Lango Trials: November.*

Centre.	N. 17.	S.G. 29.	S.P. 72.	S.P. 20.	L.S.D.	Average at each Centre.
Ngetta ..	30.7	13.0	33.7	17.7	13.7	23.8
Aduku ..	16.7	8.5	19.7	6.0	—	13.5
Kaberaimaido ..	13.5	12.0	11.7	8.5	—	11.4
TOTALS ..	61.0	33.5	65.2	32.2	18.0	—

Conclusion:—S.P. 72 = N. 17 $\triangleright$ S.G. 29 = S.P. 20.

(c) *Three Busoga Trials: December.*

Centre.	N. 17.	S.G. 29.	S.P. 72.	S.P. 20.	L.S.D.	Average at each Centre.
Vukula ..	15.2	15.5	12.5	12.2	—	13.9
Bugaya ..	11.2	9.0	7.7	6.7	—	8.7
Bulopa ..	23.0	7.5	10.0	7.7	—	12.1
TOTALS ..	49.4	32.0	30.2	26.6	16.0	—

Conclusion:—N. 17 $\triangleright$ S.G. 29 = S.P. 72 = S.P. 20.

The foregoing tables give a very consistent picture of the relative resistance of the varieties dealt with, and this in spite of the very small populations encountered in most cases. In fact one of the interesting points about the District Variety Trial series is the way in which the usual order of preference is maintained even when the population is hardly removed from zero. It appears from this that the Jassid nymph count affords a means of comparing the resistance of new varieties against that of varieties of known resistance, even when the Jassid population remains relatively low. However, there are some indications that this count loses its sensitiveness when applied to very young plants, or plants that are drying up. The unusual order in the Busoga Variety Trials (Table IV (c)) is in part due to the very poor condition of two of them.

In considering the results of these counts it should be borne in mind that there are no markedly susceptible varieties included in any of them. S.P. 72, which has the highest population in nearly every case, is only very moderately susceptible, and is probably sufficiently resistant to Jassid to make it immune to any real damage under any conditions likely to be experienced in Uganda.

N. 17.—The relatively high position of this variety in Table IV is to a certain extent misleading, as it is found that a considerable proportion of nymphs recorded on it are found on a few isolated plants which have many more Jassids than their neighbours. It is interesting to note that the Nariama group (including S.P. 72) was originally selected from N. 17, which is a very mixed variety.

S.G. 29.—The very low position of this variety in some of the tables may be partly due to the poor condition of the plants in many plots; however, there is no doubt that it possesses a high degree of Jassid resistance.

S.P. 20.—One of the outstanding results of these tables is the very low position occupied by S.P. 20 in all cases, its only competitor in this respect being S.G. 29.

COTTON STAINERS (*Dysdercus* spp.).

Only three species, *Dysdercus cardinalis*, *D. nigrofasciatus*, and *D. supersticiosus* have been seen on cotton in the Eastern Province during the past season. Of these, *D. cardinalis* was much less common than the other two, and was not met with outside Lango and Teso. Outside Serere only casual records are available, but stainers were nowhere seen or reported to be at all numerous* till the end of the season. At Serere weekly counts of the stainer population were made, but the figures give only a rough indication of the course of the infestation, as the method of sampling was unsatisfactory. During the coming season it is intended to adopt the method worked out at Barberton, which should enable an exact comparison to be made with the position in other countries. The course of the infestation was roughly as follows:—

Stainers began to arrive in the crop towards the end of August in small numbers; nymphs were first seen at the beginning of September, and became numerous towards the end of the month; these became adult during the second half of October, and the first nymphs of the F2 generation became adult during December. After this there was too much overlapping to distinguish further generations, but the number of nymphs present fell heavily at the end of December, following a dry spell in the early part of the month and coinciding with the maturation of the F2 generation, and remained at a relatively low level till the end of the season. The adult population also declined steadily from its peak at the end of December, probably due to emigration from the crop.

The severity of infestation and the relative proportions of the two main species concerned varied greatly among the different blocks of cotton at Serere. On those blocks which were lightly infested, *D. nigrofasciatus* formed the majority of the population throughout the season; on the more heavily infested blocks the great majority of the original immigrants were *D. supersticiosus*, which also made up the bulk of the F1 generation, but later in the season *D. nigrofasciatus* was in the majority on these blocks as well. The lightly infested blocks owed their immunity to a large extent to the absence of *D. supersticiosus*.

At the peak of the F2 generation the adult *Dysdercus* population on Block A of the Main Farm reached an estimated density of about 3,500 per acre. This was apparently worse than usual at Serere. The amount of *Nematospora* stain was low till near the end of the season, but the tail end of the crop was very badly stained. Boll analyses at this stage showed that about 75% of the locks were badly stained, a considerable proportion of this figure representing complete loss of crop. Nearly all this was due to infection carried by *Dysdercus*. At this time there was not nearly so much staining in the native shambas around Gola, but this was perhaps entirely due to the fact that these were planted very much later, and hence did not become infested till much later in the season.

*Stainers were reported to be exceptionally numerous, and to be doing considerable damage in West Nile, but no precise information is available.

In addition to the population counts and boll analyses on which the foregoing account is based, a weekly record is kept of the stainer population on wild *Malvaceae* in order to determine their importance as alternative host-plants.

At the suggestion of the Assistant Botanist the viability of seed from stained cotton was investigated. The seed was collected at the end of the season off one of the $\frac{1}{4}$ -acre Increase Plot, when a large proportion of the cotton was stained, almost all due to *Nematospora*. The contents of each lock was graded according to the amount of staining, Grade 1 being absolutely clean and Grade 5 being the worst stained cotton likely to be picked in harvesting. Each grade was ginned separately, and the seed sorted into four groups:—(a) well filled seed; (b) light seed; (c) shrivelled seed—unlikely to germinate; and (d) completely shrivelled—obviously incapable of germination. Germination tests were done on unsorted seed from Grades 1 and 2 (slightly stained), and on groups (a), (b) and (c) from Grade 5.

TABLE V.

A. Composition of Seed from Each Grade.

	Grade 1.	Grade 3.	Grade 4.	Grade 5.
Group (a)	85%	58%	54%	32%
Group (b)	15%	38%	41%	37%
Group (c)	—	4%	4%	17%
Group (d)	—	—	1%	13%
No. of seeds examined ..	139	143	267	215

B. Germination Test.

	Grade 1.	Grade 2.	Grade 5 (a).	Grade 5 (b).	Grade 5 (c).
No. of seeds used	100	100	70	80	50
% germination	60	47	68.5	35	4

From this it appears that about 30% of the seed from Grade 5 is viable, as against 60% from perfectly clean cotton. It should be noted that this amounts to very much more than 30% by weight. Much of the group (a) seed from Grade 5 had stained fuzz.

LYGUS.

The correct name of the *Lygus* commonly found on cotton in Uganda has recently been shown (W. E. China, *Bull. Ent. Res.* XXVI, p. 427, December 1935) to be *L. simonyi*. Reut., and not *L. vosseleri*, Popp., under which name it had been referred to in previous reports.

Incidence.—In the middle of August *Lygus* damage was severe on much of the cotton at Serere and in many other parts of Teso, but by the middle of September there was a big improvement, recent growth being relatively free from *Lygus* damage. This was noticeable everywhere on earlier sown cotton, while later sown cotton to a large extent escaped serious damage. There was a steady decline in the amount of damage after this, till with the gradual cessation of vegetative growth during November it ceased to be of any further importance. The total effect in yield was probably small. The severe damage noted in August was observed to coincide with a very high *Lygus* population in several localities, while a month later the population was everywhere fairly small. Outside Teso at this time some damage was noted on the variety trials at Kachumbala and Mulanda; on the other hand the variety trial at Kibale was practically free, while in Busoga generally *Lygus* damage was slight, the "clean" appearance of the cotton plants in many areas being in striking contrast to parts of Teso. The only appreciable damage noted during the latter part of the season was an isolated case in Lango, where a severely damaged plot was seen at Dokolo as late as November 20th; on the same date the variety trial at Kaberamaido was found to be moderately infested.

Methods of Estimating Damage.—So far all methods of estimating damage have been based on the amount of leaf damage present. Various modifications of this idea have been tried during the past season. A careful examination of the results obtained by the older methods clearly indicates that so-called varietal differences may be entirely due to the prejudices of the observer. It is hoped that a reasonably satisfactory method has now been evolved, which should

eliminate personal bias. It is designed to give a sample of the leaf damage done during the preceding fortnight:—

The top four leaves on the main stem and the first leaf on the sympodium subtended by the 4th leaf are examined, each leaf allotted a mark on the following scale:—

- 0=no damage,
 $\frac{1}{2}$ =slight damage,
 1=slight—moderate damage,
 2=severe damage,

and the total for the five leaves is the mark allotted to the plant, odd $\frac{1}{2}$ marks being disregarded. With practice this is a rapid and accurate method of assessing damage, and if a number of plants are counted it gives a good idea of the leaf damage to the plot, though the figure arrived at is a purely empirical one.

Lygus, unlike Jassid, is not at all selective in its action, attacking all varieties more or less indiscriminately. However, there are indications of small, though fairly constant differences in leaf damage (apart from differences which can be shewn to be due to personal bias). At present it is impossible to say whether, or to what extent, these correspond to differences in damage to the crop, but it is hoped to go into the question of the exact nature and extent of varietal differences more fully during the coming season.

Relationship Between Lygus and Jassid Damage and Soil Factors.—Though there was little difference between varieties in respect of *Lygus* damage, there were very marked differences between different parts of the experimental block at Serere. When comparison was made between counts done on different dates, it was found that the distribution of *Lygus* damage corresponded very closely; some parts of the field consistently showed relatively severe damage, while other parts were always lightly affected. Individual plots often showed very severe or very light damage in several successive counts, covering a period of two months, while the main areas of heavy and light damage were constant throughout the season; this was in spite of the frequent changes in the method of counting and other sources of error, which probably account for a good deal of the discrepancy between different dates which did occur. There is always a well-marked edge effect with *Lygus*, the edges of any large plot being more lightly attacked than the rest of it; however, this completely fails to account for the variations in incidence which actually occurred. The field is almost level, and there appears to be no reason which can account for these variations except soil factors. Comparison was made between the distribution of *Lygus* and Jassid attack. The following table shows the comparison between *Lygus* attack in August—September and Jassid population in October—December, for the 3 × 1 spacing of the second sowing date of the Combined Spacing—Sowing Date—Variety Trial; the figures are the percentage deviation from the mean in each case:—

TABLE VI.

Block.	Jassids.				Lygus.			
	Oct.	Nov.	Dec.	Total.	Avg. 20th.	Sept. 7th.	Sept. 24th.	Total.
I.	66	70	80	216	94	68	77	239
II.	93	123	114	330	104	117	123	344
III.	112	118	105	335	106	108	112	326
IV.	113	90	101	304	92	89	87	268

The agreement is remarkably close. Other comparisons were not so striking, and showed frequent discrepancies, but in all cases these could be partly explained by one set of figures being incomplete or in some way unreliable. However, there is good evidence that in this field the distribution of *Lygus* and Jassid was determined by the same place factors. The example given is of particular interest as the figures refer to widely different dates, showing that the determining factors are of a durable nature. Soil samples have been taken, and the question is being further investigated by the Agricultural Chemist.

A further observation of interest was the difference between the experimental block and the Botanist's breeding plot when the Jassid population was at its peak. These two blocks were side by side; the former had been opened up during the previous season and planted with *Stizolobium* in the usual way, and had a relatively high Jassid population accompanied by considerable leaf-reddening; the latter, after growing a crop of tobacco, had been treated with compost before being planted with cotton; the Jassid population on this plot was much lower and there was little leaf-reddening, while the plants were altogether greener and holding their leaves much better.

HELOPELTIS.

During the past season damage from this pest has not been serious. Early in the season some *Helopeltis* appeared on the Experimental Block at Serere, but by the beginning of August they had completely disappeared again, and the plants had recovered from any slight damage inflicted. During the remainder of the season this insect was never even seen at Serere. Apart from this and a plot on the Teso—Bugwere border, where a few bolls showing the puncture marks of this insect were seen in December, there is no evidence that *Helopeltis* was present anywhere in Teso during the past season. Lango, too, was almost completely free, the only record being a lightly infested plot near Aduku. On the other hand it seems to have been fairly prevalent in Bugwere, the triangle between Bukedea, Pallisa, and Iki-Iki being reported as showing a large number of infested plots. The variety trial at Kibale in this area was badly infested, the main attack occurring in August and September; when this trial was visited again in December these insects had completely disappeared, and had been gone some time, but many of the plants had been unable to recover. The variety trial at Mulanda, in Budama, showed slight damage in September, and both adults and nymphs were present, but the infestation did not persist, and the plots completely recovered. In Busoga some damage was caused in certain areas, mainly early in the season; badly infested plots were seen by the writer near Iganga, around Bukova, and at Vukula. A report on soil samples collected by the Agricultural Officer, Mr. T. R. Hayes, from adjacent lightly and badly attacked plots will be found in the report of the Agricultural Chemist. The observations of the writer all tended to confirm the general experience that damage by this pest is mainly confined to cotton growing on poor soils.

TABLE VII.

KIBALE VARIETY TRIAL: AVERAGE NUMBER OF ATTACKED PLANTS PER PLOT.

<i>N. 17.</i>	<i>S.G. 29.</i>	<i>S.P. 72.</i>	<i>S.P. 20.</i>	<i>L.S.D.</i>	<i>Average for Whole Trial.</i>
60.7	30.7	64.7	17.2	30.5	43.4

Conclusion:—S.P. 72 > S.G. 29 = S.P. 20.

S.P. 72 = N. 17 > S.P. 20.

Though too much importance cannot be attached to the results of an isolated experiment, this is very interesting as being the first clear indication obtained in this country that some varieties may be more susceptible to this pest than others. It is also of interest to compare this result with the conclusions drawn from Table IV (a).

A. M. GWYNN,

Assistant Entomologist.

Report on a Year's Investigation of *Platyedra gossypiella* (Pink Boll Worm) in Uganda.

(MARCH, 1935, TO APRIL, 1936).

By T. H. C. TAYLOR, ASSISTANT ENTOMOLOGIST.

I. HISTORY AND PRESENT DISTRIBUTION IN UGANDA.

P. gossypiella was first discovered in Uganda by Mr. E. F. Martin, Agricultural Officer, at Dufile, West Nile, in November, 1931. Almost simultaneously it was found at Attiak, Gulu, by Mr. G. H. E. Hopkins, Entomologist. There is now good reason to believe that it first reached Uganda at least one season, and probably two seasons, earlier.

It spread with comparative rapidity, mainly southwards. By the end of the 1934-35 cotton season it had spread as far as Kampala and had occupied the area West Nile—Gulu—Lango (mainly north)—Bunyoro—Mengo (including Bugerere)—Mubende—Entebbe—Toro (east)—and Masaka (north). It had not been found south of Masaka, and it apparently had not spread eastwards across the Victoria Nile or into Teso.

The present position (*i.e.*, at the end of the 1935-36 season) is not greatly different from that of a year ago. The only important difference is that the insect has spread across the Victoria Nile to Kamuli in Busoga, and this is its first occurrence in the Eastern Province. It has also appeared at Kabwoko, south of Masaka. Teso still appears to be free from it.

Although the insect is now widely distributed it is not present in all of the plots within the infested area. In fact, at the beginning of the season it was present in only a small proportion of them. At the end of the season it was found to be absent in 20% of the plots examined in Gulu and West Nile where it has now existed for at least 5 years, and in other parts of the infested area it was found in only about 50% of the plots examined.

II. BIONOMICS.

The general habits of *P. gossypiella* are very well known, having been studied in many different countries, and it is unnecessary here to give a full account of them. The species is, however, very versatile and highly adaptable to different climatic conditions, and consequently many aspects of its bionomics must be studied anew in each country in which it makes its appearance. In the account which follows, therefore, emphasis is laid upon the various respects in which the habits of the insect in Uganda conditions differ from those recorded in some, at least, of the other countries in which it has been studied.

(a) Eggs and Oviposition.

The eggs are laid on any part of the cotton plant, but sheltered situations are markedly preferred. The majority are laid on bolls, beneath the calyx lobes, and a very strong preference is shown for half-grown bolls when bolls of all sizes as well as buds and flowers are available. When bolls are absent or rare, but buds and flowers are plentiful, the preferred sites are the furrows and glandular pits at the bases of the segments of the epicalyx of the buds and the flowers. At all times, however, eggs are to be found, although in much smaller numbers, in a variety of other secluded positions on the plants, such as the axils of leaves and cracks due to blackarm and other causes in the stems.

The eggs are most frequently deposited in small groups of 2 or 3, but not infrequently they are laid singly and occasionally more than 3 are deposited together, the maximum number observed in one group in Uganda being 9. They are not difficult to detect in the field, and are readily distinguishable from the eggs of all other insects occurring commonly on cotton in Uganda (notably the other boll worms, *Argyroplote leucotreta*, *Earias biplaga*, *E. insulana*, and *Pyroderces* sp.).

The moths copulate and oviposit very readily in captivity if suitably treated. Since statements to the contrary are common in the literature on the subject, it seems desirable to outline the procedure adopted in Kampala for obtaining eggs in large quantities in the laboratory for experimental purposes. The most satisfactory results were obtained by enclosing the newly-emerged moths in cages with wire gauze sides and of about 1 cubic foot capacity. About 10 newly-emerged males and females were put in each cage, and food was provided in the form of honey, only very slightly diluted, upon a pad of cotton wool. The moths were left in the cages for 4 days, and the females were then removed to glass tubes (4" × 1"), one per tube, the tubes being plugged with cotton wool. Food was provided in the form of a single large drop of slightly diluted honey placed on the glass inside each tube, near the bung. Otherwise the tubes were empty. The moths lived for many days in these tubes and oviposited nightly upon the glass, the eggs being laid in large batches, often of 50 or more. About 60% of the females yielded fertile eggs. The provision of cotton bolls, or cotton in any form, is wholly unnecessary, the only essential, to induce copulation and oviposition, being an ample supply of food.

(b) Habits of Newly Hatched Larva.

Larvae resulting from eggs laid upon parts of the plant other than buds, flowers, or bolls are often obliged to wander relatively long distances over the stems before finding suitable food. They are guided to some extent at this time by heliotropic tendencies (noticeable also in the laboratory) which cause them mostly to ascend the stems and therefore enhance the probability of their reaching buds or bolls. It is likely, however, that a large proportion of such larvae perish as a result of exposure, exhaustion, the attacks of predatory insects, and also, in wet weather, inability to move over wet stems. In Kampala, the newly hatched larvae have been observed to succumb rapidly to hot sun and to thin films of moisture on the surfaces on which they find themselves. There is no evidence to suggest that the very young larvae are capable of feeding to any appreciable extent upon any parts of the plant except buds, flowers, or bolls, and it is certain that they can normally mature only in the interior of buds, flowers, or bolls. Ballou, writing of this insect in Egypt, has reported that the larvae very occasionally bore into the stems, but this practice has never been observed in Uganda and is, in any case, to be regarded as a rare and negligible occurrence.

The young larva, then, requires to penetrate into a bud, flower, or boll, and those larvae resulting from eggs laid on, or in close proximity to, these organs (*i.e.*, the majority of larvae) at once find themselves in the vicinity of a suitable food-supply and do not wander over the plant. The actual penetration of the wall of a boll, however, appears to present many difficulties, and many larvae have been observed, in Uganda, to perish through inability to do so. All larvae attempt to bore into the bud or boll within 2 hours after hatching, and while those on buds appear always to be successful in gaining access to the interior, many of those on bolls are by no means similarly successful. A larva on a bud can penetrate to the interior at any point; but a larva on a boll always pushes its way beneath one of the calyx segments, which cover the proximal half only of the boll surface, before attempting to bore through the boll wall. It would appear that, as a result of the relatively hard and smooth surface of the boll, the larva requires the greater purchase provided by contact with the closely fitting calyx in order to penetrate into the boll, and it is also likely that the region covered by the calyx is less tough. By no means all the larvae, however, which find their way beneath the calyx succeed in penetrating to the interior of the boll. Many of them wander for several days over the boll surface, nibbling occasionally at the epidermis, but eventually they die without having grown appreciably. It is only the larvae which reach the interior of the boll which have a chance of survival, and even these do not all survive. Some die, presumably from exhaustion, actually inside the boll wall. Others, having successfully penetrated the boll wall, die subsequently, apparently because normal respiration is prevented, in these particular cases, by the large amount of moisture in the developing lint.

The entrance holes made by the young larvae in buds and bolls are very minute. Those in buds are apparent subsequently as black dots, due to callusing of the neighbouring tissues; those in bolls can be detected easily for a few days by the presence around them of minute particles of the boll wall which have been ejected by the larvae, but these soon disappear and subsequently the holes can seldom be detected with certainty. External examination of a boll, therefore, never affords satisfactory evidence of the presence or absence of larvae within it.

(c) Food of Larvae Attacking Cotton.

In Uganda, the larvae have been found feeding only upon buds, flowers, and bolls (including ripe seed). Within these limits the only preferences shown by the larvae are that healthy tissue is strongly preferred to unhealthy tissue, and that immature bolls are strongly preferred to mature bolls.

The larva of *P. gossypiella* is incapable of migrating from one part of a cotton plant to another and makes no attempt to do so. The entire development of a larva is passed within a single bud (which may or may not produce a flower while the larva is still inside) or a single boll. In these circumstances, the food of the larva is predetermined to a great extent by the moth in selecting sites for the deposition of its eggs, and this point must be borne in mind in any consideration of the preferred food of the larva.

When the bolls and buds are equally plentiful, in the field, or when bolls are more common than buds, the percentage of bolls attacked greatly exceeds the percentage of buds attacked. This is attributable, not to any preference for bolls on the part of the larva but to the fact that the most suitable site for the deposition of eggs by the moth, which seeks the most sheltered places for this purpose, is beneath the calyx of the immature boll. The calyx of the bud fits so tightly, except at the extreme apices of its segments, that the moth cannot thrust its ovipositor beneath it, and it is, in any case, too small to afford appreciable shelter.

When, on the other hand, buds are more plentiful than bolls, the percentage of buds attacked is, in general, at least as great as the percentage of bolls, and *P. gossypiella* is equally a bud worm and a boll worm. Predominance of buds over bolls results in the moths experiencing difficulty in finding the bolls in sufficient numbers for their requirements and, therefore, depositing their eggs to an equal or greater extent upon the buds.

As a general rule, the rate of development of insects is a reliable indicator of the degree of suitability of the food with which they are provided, the maximum rate of development indicating the most suitable and the preferred food. Larvae of *P. gossypiella* mature at the same rate whether they are fed upon fresh buds, fresh flowers, or fresh immature bolls, and this rate is always the maximum observed at the temperatures prevailing at the time. Moreover, a constant supply of fresh food, whether in the form of buds, flowers, or immature bolls, results in the production of moths of maximum size. It is clear, therefore, that the larva, as such, has no preference, within these limits, and that any apparent preference for bolls which may be recorded as a result of field observations is attributable to the moths, not the larvae. The young

larvae bore into buds and bolls equally readily, but the moths prefer the bolls for oviposition. This aspect of the bionomics of *P. gossypiella* is stressed here because the literature of the insect contains many statements to the effect that the larvae prefer bolls, and because the popular name of the insect ("Pink Boll Worm") is misleading to agricultural investigators generally and is not sufficiently representative of the damage done. Actually, the easiest way to detect the presence in numbers of this insect in any particular cotton plot, at least in Uganda, is to walk through the plot and glance inside a few of the flowers, rather than to collect a large sample of bolls and laboriously open each one and examine it internally. The latter procedure is, however, necessary before any definite pronouncement of the absence of the insect can be made.

The relative rates of development of *P. gossypiella* larvae and cotton buds in Uganda, are roughly such that if a larva, upon leaving the egg, bores into a half-grown bud, already showing yellow at the apex, then at the time when the bud opens as a flower, the larva is in its final (4th) instar and requires to feed for not more than 2 more days. Thus, there is ample time for a larva to complete its feeding within the normal period of development of a bud, and this very commonly occurs. A single bud, unless attacked exceptionally early, provides sufficient food. Within a bud, the larva usually feeds upon the developing stamens only until it reaches the last instar. If the bud was so young when first attacked that it does not open before the larva is fullgrown, it is eventually completely emptied by the larva so that only the petals remain; and these soon die and dry to form a brittle shell completely enclosing the larva which, meanwhile, finishes its feeding by attacking the immature ovary at the base of the bud. If, alternatively, the bud is considerably older when first attacked, it usually opens to produce a normal flower, thus exposing the stigma with the larva upon it. The larva always hides itself amongst the stamens, which it spins together with silk and thus forms a tunnel, but its presence can be detected easily enough by discoloured patches, due to its frass, amongst the anthers. The flower closes within 24 hours in the usual way, and the larva is thus once more enclosed. The stigma and anthers often constitute enough food, by themselves, for the requirements of the larva, but more frequently the larva, having attained its last instar, bores into the base of the stigma and penetrates into the ovary, where it completes its feeding.

Very little damage is done to a bud by the larva in the first 3 of its 4 instars. It is still comparatively small at the end of the 3rd instar, and it attacks no vital organs within the bud. During this time, therefore, the bud continues to develop normally, and it is not until the last instar that the larva becomes large enough to do extensive damage. In this connection it is interesting to note that while the majority of buds attacked are destroyed and shed, either as such or soon after they have become flowers, normal bolls sometimes develop from attacked buds because the larvae, in these cases, have fed upon the stigma and its appendages only and have not destroyed these organs completely until after fertilisation has taken place.

The preferred food of larvae in bolls is undoubtedly the immature seeds, except during the first instar when the lint is usually devoured. As in the case of buds, very little damage is done until the larva attains its last instar. A small boll, not more than a quarter grown, is completely emptied by a single larva. A full-sized boll, on the other hand, is not very extensively damaged if it is attacked by one larva only, although the actual damage is liable to great variation. Sometimes only two seeds are attacked, in which case they are entirely emptied so that only the seed-coats remain. More frequently many seeds are attacked and rendered useless, though not all of those attacked are hollowed out completely. The seeds attacked may be all in one loc, or they may be in two or more adjacent locs, the larva having bored through the intervening septa.

An important possibility is that of larvae surviving with only ripe seed as food. It is well known that large larvae can feed successfully on dry ripe seed, but it does not follow that larvae which, upon leaving their eggs, reach the seed in open bolls in the course of their wanderings, can feed on this seed and develop normally. A series of experiments have been conducted at Kampala to settle this question. In the first experiment, conditions were made as favourable as possible for the newly-hatched larvae by the provision of seeds cut in half, so that the larvae could reach the interior without having to bore through the very hard and tough seed-coat. A hundred larvae were used, and they were provided with split seeds only; and the seeds were changed every 2 days to ensure a normal supply of moisture. After 2 weeks only 10% of the larvae were still alive, although about 40% had started feeding, apparently satisfactorily. The site chosen for feeding was the space between the testa and the endosperm, and the latter constituted the food. After 5 weeks, only one larva was still alive, and this one died a week later and was still very small. The larvae which lived for several weeks all moulted more than once, the number of moults varying from 2 to 4, but no extensive growth took place. It was obvious that ripe seed was wholly unsuitable as food for young larvae and that larvae fed from the outset on ripe seed alone cannot mature. Another experiment showed that first instar larvae are, in any case, incapable of penetrating the seed-coat, so that they can obtain no food at all from normal undamaged seed. A third experiment showed, however, that a small percentage of late 2nd instar larvae and the majority of 3rd instar larvae, if fed up to these stages on fresh buds or bolls, could, when provided with dry ripe seed only, bore through the seed-coat and gain access to the endosperm. It was found, moreover, that some of these larvae, although again only a small percentage, could eventually mature on ripe seed only. Their growth, however, was exceedingly slow, and when full grown they were exceptionally small and did not pupate, but entered upon a resting stage.

The general conclusions from these experiments were that open, mature bolls, cotton seed, and seed cotton do not constitute suitable food for the larvae, and that the larvae which may, in special circumstances, mature therein in the field or in stores are so few as to be negligible.

The extensive accumulation of dead, rotten, buds, flowers, and young bolls which is often present beneath cotton plants is, in wet weather, an important source of food for this insect. In certain conditions (*vide* Section VII) large numbers of buds and young bolls containing immature larvae are shed from the

plants, and fall to the ground with the larvae inside them. These buds and bolls soon decay and the larvae continue feeding in the decayed tissues, and, if necessary, wander over the ground and complete their feeding in other rotting buds or bolls which they may find. These larvae are always unpigmented and transparent, and are not recognisable as "Pink Boll Worms" except when carefully examined with a microscope. They pupate in due course, but the pupae are always undersized, and although rotten tissue can serve for food for all instars except the first, the rate of development is always very much slower than the normal. In dry weather also, the dead bolls and buds on the ground harbour and sustain a few larvae, but in this case a very small and negligible proportion of the larvae survive.

In connection with the food of the larvae, brief mention of their cannibalistic tendencies must be made. They are very highly cannibalistic, and when two are confined together in a small space so that they meet, one invariably destroys the other. In buds and small bolls, there are very frequently several small larvae, but in almost all cases only one matures, this one having killed, and often devoured, the others. Freshly killed and partially devoured larvae are commonly to be found. In large bolls also cannibalism occurs, but much less frequently since the available food supply is much larger and the larvae often remain separated by the septa. The larvae destroy not only others of their own kind but also larvae of *Argyroplote leucotreta*. The latter, however, are much less cannibalistic and seldom, if ever, destroy *P. gossypiella*. It has been noticed, although the observations cannot be said to be entirely conclusive, that in plots where *P. gossypiella* becomes common at the end of the season *A. leucotreta* decreases greatly in numbers although the food supply is still ample for both, whereas in plots where *P. gossypiella* is rare or absent *A. leucotreta* becomes very plentiful towards the end of the season. It is possible that the aggressive habits of *P. gossypiella* are a contributing factor in the decrease of *A. leucotreta* in these cases.

(d) Site Chosen for Pupation and Preliminary Activities of Larva.

It is generally assumed and often stated that the larva, on completing its growth, leaves the boll which it has attacked and drops to the ground to pupate on or in the soil. This, while undoubtedly true of a considerable proportion of the larvae in Uganda, does not satisfactorily represent the facts in the Protectorate as a whole.

Two or three days before the larva in a large, but immature, boll is fully fed, it bites a neat circular hole in the boll wall without, however, penetrating the outer epidermis. The latter persists for a time as a thin and semi-transparent covering to the hole, but very soon it dries and cracks, thus admitting the passage of air to the larva without causing the end of the burrow of the larva to be completely open. The larva, meanwhile, withdraws into its burrow and continues feeding. The penetration of the boll wall before the larva has finished feeding appears to be an invariable practice. It is clear that a hole must be made whether pupation is to take place in the soil or in the boll, for there is no other means of exit and the pupa and moth, in the event of pupation taking place within the boll, are themselves incapable of penetrating the wall. Nevertheless, this does not explain why the hole is made so long in advance. The only satisfactory explanation appears to be that the large and active 4th instar larva requires a more plentiful supply of air than has previously been available to it within the boll.

In the cooler and more humid parts of Buganda, and probably elsewhere in Uganda, at least 30% of the larvae pupate within the bolls as a general rule. There is considerable evidence to indicate that in very wet, cool weather the number pupating inside the bolls amounts to 50%, but the infestation has not yet been heavy enough to render more accurate data obtainable. In the drier and hotter parts of Buganda (e.g., Buruli), and in Gulu and West Nile Districts of the Northern Province, pupation inside the boll appears to be an exceedingly rare and negligible event. Out of 2,000 infested bolls examined in West Nile in January and February, 1936, not one contained a pupa, and this result was most striking as compared with that obtained in the wetter and cooler parts of Buganda in January, 1936, as well as in March and April, 1935. Moreover, a study of the literature from other countries (Mexico, India, Egypt, Sudan) indicates, though it does not prove, that a hot, dry climate induces the larvae to leave the bolls* and that a cooler and wetter climate tends to induce them to pupate inside the bolls. Thermometer observations taken in the course of journeys in Uganda in 1935-36 show that the larvae leave the bolls in those areas where the shade temperature exceeds 85°F for several hours every day (the corresponding humidity being between 30% and 40%), and that they commonly pupate inside the bolls in areas where the shade temperature seldom exceeds about 80°F (the corresponding humidity being more than 55%). It is likely that this is a direct temperature effect and that humidity plays no part in it; for the humidity inside a larval burrow in a boll must remain high, even after the larva has made an exit hole in the boll wall. No exact data, however, are yet available.

Larvae which leave the bolls when fully fed almost invariably pupate on the surface of the soil in the cooler parts of Uganda, under dead flowers, leaves, and other debris beneath the cotton plants. They seldom utilise cracks in the soil for shelter, or burrow into it. In the hotter districts, where the larvae all leave the bolls, it is possible that pupation may commonly take place in the soil, the larvae requiring more shade and lower temperatures than the surface of the soil affords. This question has not yet been examined in the hotter districts.

Very frequently pupae are found in Buganda Province inside dead buds, young bolls, and flowers upon the surface of the ground. The attacks of the larvae upon buds, flowers, and young bolls usually cause them to drop to the ground, and the larvae (and sometimes pupae) drop with them and remain inside them.

* Except when it is extreme enough to induce the resting stage. *Vide* Section II, (k).

Mature bolls often open before the larvae inside them are fullgrown. In this case, the larvae complete their feeding in the ripe seeds and many of them, in the cooler parts of the Protectorate, pupate in the emptied seeds and also, and equally commonly, in the lint, and therefore remain on the plants. These pupae are removed with the crop at the next picking, and the moths which emerge from them are found in cotton stores. In the hotter areas, the larvae in open bolls usually leave them when fully fed and are often to be found wandering in the baskets of cotton at native markets.

The cocoon* is an elongate and very flimsy structure, closed at the posterior end, and at the other open or with a few delicate cross-strands of silk which only partially close it. The open or partially closed end tapers to form a silken tube or tunnel which leads to the outside of the shelter in which the cocoon lies. Thus, if pupation takes place inside an immature boll the tunnel extends to the hole in the boll wall, or if it takes place under a leaf on the ground the tunnel leads to the edge of the leaf. The tunnel serves for the emergence of the moth. The fact that the cocoon is never entirely closed anteriorly is important from the point of view of parasite attack.

An interesting fact in connection with the site chosen for pupation is that all the larvae in fruits of *Hibiscus macranthus*, an alternative host plant in the wetter parts of Uganda, appear to pupate in the fruits.

(e) Life Cycle.

The rate of development varies considerably according to the nature and condition of the food and to the temperature. At any given temperature, the most rapid development takes place when the larvae are fed upon fresh buds, flowers, or bolls of cotton, and the rate observed in these circumstances is to be regarded as the normal rate for the species. In April, 1935, the following records were obtained in Kampala:—

Incubation period	..	..	..	5½ days (mean for 20 egg masses).
Larval (including prepupal) period	..	..	..	15 days (mean for 20 larvae).
Pupal period	..	..	..	9½ days (mean for 40 pupae)
Total period (oviposition to emergence)	..	..	..	29½ days (mean for 20 individuals).

The observed variation in duration of these 4 periods was 5¼–5¾, 14–17, 9–10½, and 29–31, days respectively. The individuals from which these records were obtained were all reared in glass tubes in the laboratory and were fed with fresh young bolls. Confirmation of the larval period was obtained in the field at the same time by artificially infecting 20 half-grown bolls *in situ* on the plants and removing the bolls from the plants at approximately the time when the larvae were thought to be due to make their exit holes prior to pupation.

The 4 larval instars were found, at the same time, to cover 2½, 2, 2½, and 8 days respectively, on the average, the last instar (8 days) being divisible into a feeding period of 5½ days and a non-feeding prepupal period, spent in the cocoon, of 2½ days.

The figures given above show the rate of development in moderately hot weather. In cooler weather (June and July, 1935) but otherwise in the same conditions, the following mean figures were obtained:—

Incubation period	..	..	..	..	..	6½ days
Larval period	..	..	..	..	..	19 „
Pupal period	..	..	..	..	..	13 „
Total period	..	..	..	..	..	38 „

Larvae fed upon decayed, wet, buds or bolls develop very much more slowly, and in these circumstances the larval period may be lengthened to 30 days. The pupal period, however, is not affected. Larvae fed upon dry bolls from the 2nd instar onwards develop very slowly and usually enter a resting stage when fullgrown, and in these special cases, but not otherwise, the larval period may cover many months. The resting stage is dealt with in a separate section of this report, and it is sufficient here to remark that it is a very abnormal occurrence in Uganda and need not ordinarily be taken into account in connection with the rates of development and multiplication.

(f) Duration of Adult Life.

Moths which are kept in cages without food commonly live as long as 6 days and occasionally survive for 8 days. Moths which are fed regularly with honey live for at least 14 days and often for 17 days. In Hawaii moths have been found to live in captivity for as long as 32 days, and in Egypt for 31 days, but it seems probable that in Uganda conditions the normal duration of the adult life is about 3 weeks.

(g) Egg Capacity.

The egg capacity of large females, such as those which normally result from larvae fed with buds or immature bolls of cotton, is between 350 and 500. The figures obtained from 6 large individuals were 486, 398, 459, 370, 438, and 440. Each of these moths was dissected at death and found still to contain a few eggs (never more than 20), and these are included in the above figures. The moths in question were kept, after having paired in a large cage, in glass tubes each of which contained a cotton boll. Fresh bolls were put in the tubes every day, and a supply of honey was also provided.

Smaller moths, resulting from larvae fed upon decayed bolls, proved to have an egg capacity of about 200.

These figures agree with those obtained by Willcocks in Egypt.

*The cocoon, as here described, must not be confused with that of resting larvae, referred to hereafter, which is of very different form and texture.

(h) Oviposition Period.

Oviposition usually commences on the third night of the adult life, pairing taking place on either the first or the second night. Eggs are then laid every night during the rest of the adult life, except the night which precedes death. Since the adult life covers about 3 weeks, the duration of the oviposition period is about 17 days. The number of eggs laid per night varies greatly, but a maximum (of about 70) is usually reached on the fourth or fifth night, after which the number laid per night diminishes steadily.

(i) Sex Ratio.

The sexes occur in approximately equal numbers. Out of 89 moths reared from larvae collected in the field in June, 1935, 47 were males, and 42 females.

Thus $\sigma : \varphi = 1:12 : 1:00$.

(j) Duration of One Generation.

At the temperatures which usually prevail in most parts of Uganda during the cotton season, it may be assumed that the development from oviposition to emergence of the moth covers a period of approximately 29 days. Since there is a preoviposition period of 3 days and oviposition continues for about 17 days, the mean duration of one generation is approximately $29 + 3 + \frac{1}{2}$ days or about 40 days. A plentiful supply of cotton flowers or bolls, or both, is present for about 6 months in each cotton season, and therefore the number of complete generations per season is about $4\frac{1}{2}$. Assuming a mean egg capacity of about 400 and numerical equality of sexes, a single paired female is thus potentially capable of giving rise to a population of many hundreds of millions in one cotton season. That this never actually takes place in the field is sufficiently obvious. Indeed, the actual rate of multiplication, as evidenced by the percentage infestation of bolls and rate of spreading, can be only a small fraction of the theoretical rate, and this testifies to the high degree of control, whether economically satisfactory or otherwise, which is exercised by the many natural factors operating in Uganda.

(k) The Resting Stage.

In certain circumstances there is a long diapause, usually known as the resting stage, at the end of the larval stage of *P. gossypiella*. The larva completes its normal growth and then, instead of spinning the usual cocoon and proceeding to pupate, it constructs an unusually tough, compact, and closely woven cocoon with both ends effectively closed, and remains as a larva within it. This resting stage may continue for many months, and occasionally, though not in Uganda, for nearly 2 years.

The resting stage, wherever it occurs commonly, is of great importance economically, and is, in fact, the key to control measures. In most cotton-growing countries it occurs towards the end of the cotton season and then extends through the period (usually the winter) when no cotton is present. It thus enables the insect to survive in large numbers to attack the next season's crop, whereas, if there were no resting stage, the insect would almost die out during the dead season for cotton through lack of food. Control measures, therefore, are directed mainly against resting larvae. In Egypt, the northern Sudan, Mexico, and elsewhere, the life cycle of the pest during the earlier part of the season is short, development proceeding continuously, and is similar to that already detailed for Uganda. Later, certain of the larvae enter the resting stage, and the percentage of larvae which do so steadily increases until, at the end of the season, most of the larvae are resting larvae. Since these larvae pass the winter as such, the resting stage is sometimes referred to as hibernation, but many of the larvae enter the resting stage long before the advent of winter conditions, and actually in very hot, dry weather, and the term "hibernation" is therefore scarcely applicable. There can be no doubt that hot, dry weather is one cause, directly or indirectly, of the resting stage, but it is not to be regarded as the sole cause because most of the larvae present at the end of the season, when much cooler weather prevails, also enter the resting stage.

The most common situation for resting larvae is inside the seed, either in a single seed or inside two adjacent seeds tightly joined together by the silk of the cocoon (hence the term "double seeds"). These double seeds are very characteristic of *P. gossypiella* in countries where the resting stage is a usual occurrence. They pass through the gins intact, and are therefore easily detected. Resting cocoons, however, are also formed in the soil, and in a variety of other situations.

In Uganda, the resting stage is, fortunately, an exceedingly rare occurrence. In the wetter parts of the country it does not occur at all, even in spells of dry weather. In hotter areas (Gulu, West Nile, Buruli, etc.) it has been shown by Mr. Hancock to occur, but evidently only as a very rare event, and the writer has not found a single resting larva in spite of extensive and careful searching (in the field, in ginneries, and in native markets) in hot weather at the end of the 1935-36 season. In all parts of the country the normal short cycle of development is the rule throughout the season.

The causes of the resting stage are obscure and have never been satisfactorily investigated. A number of experiments and observations have, however, been made in Uganda during the past year and these throw some light on this difficult and complex problem, and serve to indicate what we may expect in a climatically abnormal season. In the first place, the mere fact that the larvae do not normally rest in any part of Uganda at once shows that a rainfall of 40" to 60" distributed through most months of the year, a relatively high mean daily humidity (exceeding 50%), and a mean daily temperature in the neighbourhood of 70°F, with a maximum rarely above 90°F and a minimum of about 50°F, together induce short cycle development. Further, on comparing the climate of Uganda during the cotton season with

the climate, during the corresponding season, of countries in which the resting stage is a usual occurrence, it is evident that climatic factors associated collectively with the resting stage are long periods (several months) of complete drought, day temperatures exceeding 95°F, and low humidity. These considerations, together with the fact that in these other countries resting continues to occur after the advent of cooler weather, inevitably point to lack of moisture as the factor responsible for the resting stage, and if this is true high temperature is to be regarded as a contributory, rather than a determining, factor.

A preliminary experiment was conducted in Kampala to ascertain the reaction of fully fed larvae to different humidities. A hundred larvae, which were almost fullgrown but were still feeding, were collected in the field and placed in 10 sealed glass jars (10 per jar) over KOH solutions, each larva being enclosed in a small wire-gauze tube to prevent cannibalism. Each one was provided with 2 dry cotton seeds for food. The strengths of the KOH solutions were arranged so as to give humidities of 10%, 20%, 30%, and so on (the 100% jar containing distilled water only). After 10 days the larvae were carefully examined. In the 10% and 20% jars all the larvae were dead, as such, and were dry and hard; all of them had fed a little and some of them had spun normal, non-resting, cocoons before they died. In the next 6 jars (30% to 80% inclusive) all the larvae (with a few negligible exceptions) had pupated normally. In the 90% and 100% jars, all the larvae were dead and distended, as though drowned, and the results in these 2 jars were particularly uniform and striking. The conclusion from this experiment was that at the temperatures which prevailed during the 10 days (mean, 78.5°F; mean daily maximum, 82.5°F) larvae which have fed, almost throughout their feeding period, in immature bolls, show no tendency to enter the resting stage when fullgrown, no matter what humidity they are exposed to. Incidentally, it is noteworthy that constant humidities of 10%, 20%, 90%, and 100% are fatal, at the temperatures in question.

Attention was next directed to the effects of dry food upon the behaviour of the larvae as regards the resting stage. Larvae were fed throughout the last instar upon ripe seed only, in the case of one batch, and upon very small, dead, immature bolls, dried in the sun, in the case of another batch. The humidity was not controlled. The larvae had all been fed with fresh immature bolls until the last moult. The results were interesting, but inconclusive. All the larvae completed their growth, but abnormally slowly, and when fullgrown showed a definite reluctance to pupate. They constructed cocoons some of which resembled the resting type, but were less tough. Pupation took place within the cocoons after periods varying from 1 to 3 weeks, instead of the usual 2 or 3 days.

This experiment led to another, in which late 2nd instar larvae were put in 30% humidity jars and were fed on small, immature bolls dried in the sun. 20 larvae were used—10 in each of 2 jars. Only 6 of the 20 survived to become fullgrown, but these 6 all constructed typical resting cocoons, very distinct from the normal type and closely sealed at both ends. The resting period was eventually terminated by pupation within the resting cocoons, and its duration varied from 1 to 3 months. The temperature during this experiment was that of the laboratory at Kampala and varied from 72°F to 85°F, with a daily mean of 77°F.

Of several other experiments and observations made in the course of the year, only one warrants special mention. This was a simple experiment conducted at the end of January, 1936, at Arua and Okollo, West Nile. 40 larvae, almost fullgrown, were collected at Rhino Camp from nearly mature bolls. The larvae were placed in 2 identical biscuit tins without lids, 20 in each tin, and the tins were half-filled with seed cotton collected on a hot afternoon from mature, open bolls, and, therefore, completely dry except for the moisture in the seeds. On each of the 4 following days, one of the tins was put out in the sun at about 9 a.m. and left till 6 p.m. The other tin was kept in the shade in the rest camp, but otherwise the treatment was the same. The weather was hot and dry, and the daily maximum temperature, near the tin in the shade, varied from 92°F to 96°F, and the minimum from 72°F to 74°F. The humidity varied each day from about 30% (at 2.30 p.m.) to about 70% (at 6 a.m.). The temperature attained in the tin in the sun was not measured, but it certainly exceeded 110°F. The results were convincing. In the tin which had been in the sun, only 2 of the larvae pupated within the usual short-cycle period. These 2 were probably more advanced than the others when collected. All of the remaining 18 spun typical resting cocoons, and entered the resting stage therein, and all are still resting larvae at the time of writing, *i.e.*, after 3 months. The controls in the other tins all pupated about 3 days after they were collected, and a very large number of other larvae collected at the same time at Rhino Camp and kept in glass tubes also pupated as soon as they were fullgrown. Moreover, examination of open bolls at Rhino Camp revealed the presence of a number of larvae which were completing their feeding in the ripe seeds, but no resting larvae were found and the larvae in the open bolls did not rest when fullgrown. This experiment is particularly interesting when compared with the earlier one in which fullgrown larvae were subjected to known humidities at much lower maximum and mean temperatures. In the earlier experiment, none of the larvae rested at any humidity. In the West Nile experiment, in which it is probable that the humidity in the seed cotton containing the larvae never rose above 30% by day, nearly all the larvae rested. The only difference is the temperature.

We may now conclude with a reasonable degree of certainty, that the resting stage is caused by any factor, or factors, which can reduce the water content of the body. An abnormally high temperature with low humidity results in excessive evaporation from the larva itself. Dry food at low humidity over a long period results in an inadequate water supply from within, regardless of temperature within limits. These combinations of factors, and conceivably other combinations, result in a lowering of the rate of metabolism and a consequent cessation of development. The mere fact that the larva normally feeds

throughout its development inside developing bolls, the water content of which is exceedingly high, emphasizes its capacity for assimilation of water; and the further fact that larvae which are fed upon permanently saturated, severely decayed, buds and flowers pupate and produce moths in due course demonstrates that water, in quantities so excessive as to be fatal to most larvae, is tolerated by *P. gossypiella*, and this in itself implies that its normal water requirements are high.

The experiments already described show that the resting stage occurs in climatic conditions which, for Uganda, are to be regarded as extreme and abnormal. For a tropical country, the climate of Uganda in a normal year is essentially moderate in all respects (rainfall, temperature, and humidity), and even in the hottest and driest districts the climate is not normally extreme enough to induce the resting stage. It is conceivable, however, that an abnormally hot, dry season, so extreme that it can but rarely occur, might induce resting on a large scale in Gulu, Chua, West Nile, north Lango, and Teso, either by direct effect upon the fullgrown larvae or indirectly through abnormally dry food.

It is now desirable to consider briefly the causes of the termination of the resting stage. For many months no experiments on this point could be conducted with *P. gossypiella* because no resting larvae were available in the field and means had not been found for inducing resting artificially. During this time, therefore, two other species of *Platyedra* (*P. erebodoxa*, and a species which feeds on *Dombeya emarginata* and which is not yet identified) were used for experimental purposes. The larvae of these two species normally undergo a resting stage in Uganda, and material was, therefore, available in quantity. 20 larvae of each species, which had been resting for 3 months previously in glass tubes, were placed in each of 3 jars over KOH of strength arranged to give humidities of 80%, 90%, and 100%. After 2 weeks, a few of the larvae pupated and within a month all of them (except 40% of those in the 100% jar, which died from excessive moisture) had pupated. Moths emerged in due course. Meanwhile, the larvae used as controls continued resting, and after they had rested for about 3 months more (*i.e.*, 6 months altogether) they died without pupating. In the course of this experiment, 6 other resting larvae (all *P. erebodoxa*) were completely immersed in water (owing to an accident) for a period of 24 hours. These larvae had been resting for at least 2 months. When removed from the water they appeared quite dead, and were believed to have drowned. A few hours afterwards, however, they recovered, and they soon proceeded to construct normal, non-resting, cocoons, and within 4 days they had all pupated.

A number of other experiments showed that resting larvae of these 2 species could invariably be induced to pupate by exposing them to abundant moisture. It was not until March, 1936, however, that it was possible to conduct a similar experiment with *P. gossypiella* itself. Resting larvae (18) were brought to Kampala from West Nile, where they had been induced to rest by artificial means. Some of them were inside single seeds and others were in lint, but all of them had constructed typical resting cocoons. On the 20th March, when the larvae had been resting for nearly 2 months, the cocoons of all of them were opened at one end (to make absolutely certain that none had pupated), and then 9 of them were placed in a sealed jar over water (to give 100% humidity) and the other 9 were placed in a similar jar without water. On the 3rd April, one of the larvae in the jar with water had already pupated; and on the 11th April all in this jar had pupated*. All produced moths in due course. The other 9 in the jar without water continued resting and all are still resting at the time of writing (May). An interesting further point is that all the larvae in the jar without water sealed up the opened ends of their cocoons, while those in the jar containing water all left the ends of their cocoons open.

The practical significance of these observations is that in the event of exceptionally hot, dry weather causing larvae in quantity to enter the resting stage, pupation can be expected to take place as soon as the rains begin, provided the rains are normally heavy, frequent, and protracted. This means that the resulting moths will be present soon after the cotton of the next season is planted and will die before buds or bolls are present in quantity. In these circumstances, the resting stage cannot greatly affect the degree of infestation, and is not likely ever to be a factor of primary importance in Uganda in normal years or abnormally wet years. In the rare event, however, of a very hot, dry spell occurring at the end of one season and being followed by a period of less rain than usual at the beginning of the next, it is to be expected that an unusually large proportion of the larvae will enter the resting stage at the end of the one season and that the moths will emerge from them rather later than usual and so cause an unusually heavy infestation in the next season's crop.

III. ALTERNATIVE HOST PLANTS.

Summary.

An extensive survey of the possible alternative host plants of *P. gossypiella* in Uganda has been undertaken and nearly completed. A detailed account is given in Appendix I of this report, and it will suffice here to summarise the results in the following terms:—

(a) Only one family of plants, the Malvaceae, has been found to include species attacked by *P. gossypiella*.

(b) The plants found to be attacked all belong to the genus *Hibiscus* and are three in number, namely, *H. macranthus*, *H. esculentus*, and *H. cannabinus*.

(c) *P. gossypiella* shows a very marked preference for cotton and rarely attacks *Hibiscus* when cotton is present. Of the three species of *Hibiscus* attacked, *macranthus* is markedly preferred.

*It is noteworthy that in a previous experiment (already outlined in this report) saturated air proved fatal to non-resting larvae.

(d) *H. macranthus* is entirely confined to the wetter areas. As soon as the cotton is destroyed at the end of the season, *P. gossypiella* appears comparatively commonly in *macranthus* fruits for about a month, particularly in those fruits which are enlarged by a gall-forming Cecidomyid. After this, the insect, although to be found occasionally in *macranthus* throughout the period when cotton is absent, becomes very rare owing to spreading and reluctance to oviposit on *Hibiscus*. *H. macranthus* therefore, enables it to survive only in very small numbers and in only a few localities.

(e) In the drier areas, *P. gossypiella* is almost entirely without alternative host plants in the dead season for cotton. *H. macranthus* is absent; *H. cannabinus* is present but very rarely attacked; and *H. esculentus* is present also, but is infrequently attacked. Moreover, *cannabinus* and *esculentus* do not produce flowers to any appreciable extent in the drier areas during the hot, dry months when no cotton is present.

(f) The alternative host plants are unimportant, particularly in the drier areas, as compared with other factors which enable the insect to survive the dead season.

(g) Four other species of *Platyedra* have been found in Uganda. Two of them feed in *Hibiscus* fruits and a third occasionally attacks cotton. The larvae of three of them bear a close general resemblance to *P. gossypiella*. A study of these other species has, therefore, been a necessary part of the survey of host plants of the latter.

IV. THE NATURAL ENEMIES IN UGANDA AND THEIR ECONOMIC UTILITY.

Twelve species of primary parasitic insects have been found to attack *P. gossypiella* in Uganda. The following list of them, with the accompanying brief notes, will serve the purpose of this report*:—

Braconidae:—

I. *Microbracon kirkpatricki*.—External larval parasite of *P. gossypiella* in cotton. Exceedingly rare in Uganda, where it has been obtained once only (by Hancock), from Gulu. Never obtained from other *Platyedra* spp. or any other host.

II. *Microbracon* sp.—External larval parasite of *P. gossypiella* in cotton. No other host known. Female oviposits through boll wall, also in flowers. Life cycle 12 days. Not uncommon in wetter districts. Apparently absent in dry districts.

(N.B.—*Microbracon hancocki*, a common parasite of *Platyedra erebodoxa* throughout Buganda, has never been obtained from *P. gossypiella* and apparently frequents *Hibiscus diversifolius* only).

III. *Chelonella ritchiei*.—Internal larval parasite of *P. gossypiella*, *P. erebodoxa*, *P. cunctatrix* *Platyedra* sp. in *Dombeya*, *Platyedra* sp. in *Acanthus*, etc., etc. Has a great variety of hosts in many different plants. Attacks *P. gossypiella* in cotton as well as *Hibiscus*. Female oviposits in egg, larva emerges from halfgrown larva. Common and widely distributed.

IV. *Apanteles diparopsidis*.—Internal parasite of larvae of all species of *Platyedra*. Also has a great variety of other hosts. Cannot attack *P. gossypiella* inside bolls, only in flowers, etc., where larvae are accessible. Very common.

Ichneumonidae:—

V. *Asphragis* sp.—Internal larval parasite of *P. gossypiella* and *P. cunctatrix* in *H. macranthus* (never in cotton) and also, but rarely, of *P. erebodoxa* in *H. surratensis*. Female oviposits in small larvae, and larva grows with host, emerging when host is fullgrown larva. Common wherever *H. macranthus* grows.

Chalcididae:—

VI. *Brachymeria olethrius*.—Internal pupal parasite of *P. gossypiella* (in cotton and *Hibiscus*), *P. erebodoxa*, and *P. cunctatrix*. Common.

Elasmidae:—

VII. *Elasmus johnstoni*.—External larval parasite of *P. gossypiella* (in cotton and *Hibiscus*) and *P. cunctatrix*. Probably has a great variety of hosts in many different plants. Common.

Eulophidae:—

VIII. *Pleurotropis* sp.—Internal pupal parasite of *P. gossypiella* (in cotton and *Hibiscus*), *P. erebodoxa*, and *P. cunctatrix*. Life cycle 25 days. Many individuals per host (6 to 25).

Eurytomidae:—

IX. External larval parasite of *P. gossypiella*. No other hosts known. Found only in West Nile (Okollo and Rhino Camp).

Trichogrammatidae:—

X. *Trichogrammatoidea* sp. Egg parasite of *P. gossypiella* (on cotton and *Hibiscus*), *P. cunctatrix*, and *P. erebodoxa*. Has a great variety of other hosts on many different plants. Very common.

Tachinidae:—

XI. *Actia* sp.—Internal larval parasite of *P. gossypiella* (in *Hibiscus* only), *P. cunctatrix*, and *Platyedra* sp. in *Dombeya*. Probably has a great variety of hosts. Common.

XII. *Actia* sp.—Internal larval parasite of *P. gossypiella* (in *Hibiscus* only) and *P. cunctatrix*. Has a variety of hosts. Rare in *Hibiscus*, more common in certain other plants.

*Most of these have not yet been specifically named. Specimens have been sent to the Imperial Institute of Entomology for this purpose.

In addition to these insect parasites, there is the mite, *Pediculoides ventricosus*, which attacks the larva of *P. gossypiella*, but only as a very rare event. Two secondary parasites of *P. gossypiella* have been found; one (*Eurytoma* sp.) attacks *Microbracon* spp. and the other (*Perilampus* sp.) attacks *Asphragis* sp. and *Chelonella ritchiei*, both very commonly.

The primary insect parasites of *P. gossypiella* thus include 1 egg parasite, 5 internal larval parasites, 4 external larval parasites, and 2 pupal parasites. There is, in fact, a complete sequence of attack. The natural enemies are, however, of very little economic value, for the following reasons:—

- (i) Most of them have too many alternative hosts.
- (ii) Very few of them can reach larvae inside bolls, except during the short time which follows the making of the exit holes by the larvae.
- (iii) Most of them do not frequent cotton and attack *P. gossypiella* only in *Hibiscus*. These are the species which normally attack other species of *Platyedra* and attack *P. gossypiella* incidentally through inability to distinguish it from them.

The total parasitism in cotton does not exceed 10%, and is probably much less. The total parasitism in *Hibiscus macranthus* amounts periodically to about 50%, and this is mainly attributable to *Asphragis* sp. and *Chelonella ritchiei*. In the dead season for cotton this degree of parasitism in *Hibiscus* is clearly useful, but it is not nearly sufficient for effective control. The principal reasons for the failure of these two parasites to cause a higher mortality in *Hibiscus* are, firstly, that only a limited percentage of the larvae are accessible to them in those fruits of *H. macranthus* which are enlarged by the Cecidomyid, and, secondly, that one of the secondary parasites prevents them from multiplying sufficiently rapidly.

V. EXTENT OF DAMAGE.

In most cotton plots throughout the infested area in Uganda, *P. gossypiella* is entirely absent at the beginning of the cotton season. In a small percentage of the plots, however, it can be detected if a large sample of bolls is collected when bolls first become available in quantity. It is never common anywhere at the beginning of the season because of the great difficulty which it experiences in surviving the period when no cotton is present. As the season advances, the spreading of the moths causes more and more of the plots to become infested, but at the end of the season the pest is not present in by any means all of the plots even in areas in which it has been thoroughly established for several years.

In the small percentage of plots in which *P. gossypiella* is present at the beginning of the season, the extent of the infestation at this time very rarely amounts to as much as 1% of the bolls. That is to say, a sample of 100 bolls at this time may or may not reveal the presence of the pest in plots in which it is present. The maximum infestation observed at the beginning of the season is 2% of the bolls, and this only in plots near to cotton which, contrary to regulations, was not uprooted at the end of the previous season. In plots in which the degree of infestation at the outset is 1% or less, no appreciable damage is done until the extreme end of the season, when the percentage infestation of bolls amounts, in these plots, to about 25%. In the few plots in which the degree of infestation at the outset is 2% or more, the pest becomes common considerably before the end of the season, and, at the time of the last picking, may infest from 50% to 75% of the bolls. When it is considered that the number of plots infested at the beginning of the season constitutes only a small percentage, and that even in these (with the exception of the few near old cotton) no appreciable damage is done except at the time of the last picking, it is clear that the damage done to the cotton crop as a whole is very small.

This satisfactory condition is attributable to the comparative lack of alternative host plants, to the complete lack of entirely suitable alternative host plants, to the rarity of the occurrence of the resting stage, and to the thoroughness of the destruction of the old crop as at present practised. It may be suggested that an additional factor at present operating is the spreading of the pest to new areas, but, in the opinion of the present writer, this is most improbable, except near the edges of the infested area. There are many areas in which there is every reason to believe that *P. gossypiella* has been thoroughly established, and as generally distributed as is possible in existing conditions, for at least 2 seasons. Gulu, West Nile, the neighbourhood of Nakasongola in Mengo, and that of Kiboga in Mubende, may be cited as instances. Probably the best instance is the river belt which includes Laropi and Dufile in the extreme north of West Nile, and which is a relatively segregated area. It was at Dufile that *P. gossypiella* was first discovered, in 1931. The general impression of the Agricultural Officer who discovered it and who has been familiar with it in the West Nile ever since is that the degree of the infestation has been rather less in succeeding years, and an inspection of the Dufile area by the present writer at the end of the 1935-36 season (that is, after 5 years) showed an infestation of only 7% of the bolls. There can be little doubt that the insect has attained a condition of permanent equilibrium in this area.

The observations made to date indicate that the pest is able to maintain itself in every cotton district as a whole, having once become widely distributed therein, but that in many localities within each district it fails to survive from season to season. So long as this is the case, there will always be many plots in which *P. gossypiella* is absent at the beginning of the season. The rate of multiplication of the insect in existing field conditions in Uganda is such that in the duration of a normal cotton season it has only just time to become common before uprooting takes place, except in the few plots in which the initial infestation exceeds 2%. In the many plots which are initially free from it and which are infested from neighbouring plots after a month or so, it has not sufficient time to become common before the cotton is uprooted.

The failure of the insect to survive uniformly throughout any infected area, although it can survive in the area as a whole, thus becomes the key to the problem. Very many instances could be cited of its failure to survive locally, but three will suffice. At Kamengo (mile 34, Masaka road), one of the localities where special observations have been made, an infestation of 2% was observed in March, 1935, and 5% in April. This, though not heavy, represents a large population. At the end of April, just after all cotton had been uprooted very thoroughly, a large sample of *H. macranthus* fruits was collected, but although these contained *P. cunctatrix* in abundance no *P. gossypiella* was found. In June, however, *P. gossypiella* was found commonly in *H. macranthus*, and was present in about 20% of the fruits. In July, however, and again in August, no trace of *P. gossypiella* could be found in *H. macranthus*. The moths of the first generation in *H. macranthus* had evidently spread far afield in search of cotton, and in doing so had completely deserted the locality. In September, and again in November, large samples of cotton bolls of the 1935-36 crop were examined and proved to be entirely free from the pest, and it was not until the end of December that the insect reappeared, having presumably spread from a neighbouring locality. The infestation at the end of December amounted to rather less than 1%. These observations are typical of several different localities, although in some localities the insect did succeed in surviving to the next cotton season in *H. macranthus* while in other localities again it survived in cotton plants which had been overlooked at the time of uprooting. An instance of the disappearance of *P. gossypiella* is afforded by surveys of the Kampala—Jinja road. At the end of the 1934-35 season the insect was found at mile 21 only. In the following season it was not found at all between Kampala and Jinja, in spite of careful surveys in both December and April. Again, in the neighbourhood of Nakasongola (Buruli), where the insect was found in the 1933-34 season, it was observed 2 seasons later (November, 1935) to be absent from almost all plots and to be a rarity throughout Buruli although still present in the area as a whole.

At the end of the 1935-36 season, and towards the end of it, about 300 samples of bolls were collected in different parts of Uganda and carefully examined. Most of the samples consisted of 50 bolls, but some contained 100, and each sample represented one locality. In the table which follows the results of the examination of most of these samples are shown, in condensed form. Samples taken in areas (such as Busoga and Kyagwe) which have only recently been reached by *P. gossypiella* are not included. The last 3 columns show the percentages of bolls attacked by the pest. The figures in the fifth column, in which the maximum infestations are given, are often isolated cases, the majority of localities having very much lower figures; these are, however, included in the means. The number of bolls, separately examined, on which the table is based, is in the neighbourhood of 20,000, and the number for the whole season is about 30,000.

Month.			District or area.	Number of localities sampled.	Number of localities where <i>P. gossypiella</i> found.	Maximum per- centage infestation of Bolls.	Mean percentage infestation for infested localities.	Mean percentage infestation for all localities sampled.
November	..	..	Buruli	20	4	6	2.5	0.5
[December	..	..	Within a radius of 6 miles from Kampala	40	11	16	4	1]
January	..	..	Gulu	19	15	40	13	11
Jan.—Feb.	..	..	Bunyoro	25	16	66	12	8
Jan.—Feb.	..	..	West Nile	39	31	70	20	15
February	..	..	Within a radius of 6 miles from Kampala	30	21	22	9	6
February	..	..	Kampala—Bukomero ..	10	8	35	7	6
March	..	..	Mubende	18	8	32	11	5
March	..	..	Entebbe	15	9	10	5	3

It is useful first to ascertain what percentage of localities contain *P. gossypiella* at the end of the season. By summing the figures in columns 3 and 4 (but omitting the one series in square brackets which was obtained too long before the end of the season for that part of the country) it is found that out of 176 localities, 112, or 64%, contained *P. gossypiella*. Further analysis of the figures shows that the localities infested amount to 20% (4 in 20) in Buruli, 75% (62 in 83) in Gulu, Bunyoro, and West Nile, and 58% (25 in 43) in Entebbe, Mubende, and South Mengo. There is no doubt that at the beginning of the season the number of localities where the pest was then present was a very much smaller percentage in all districts; it probably did not exceed 20%, though sufficiently extensive data are not available. This difference is indicated by the two series of figures for the Kampala neighbourhood, where about 27% of the localities were infested by December and 70% by February.

The mean percentage infestation of bolls varied at the end of the season from 0.5 in Buruli to 15 in West Nile. The mean for the whole area (*i.e.*, the greater part of Buganda and the Northern Province) is in the neighbourhood of 7% only.

It cannot be too strongly emphasized that these figures apply to the end of the season only. The pest always appears to increase greatly and suddenly in the last generation of the season. This is due partly to the fact that in the earlier part of the season the output of bolls increases more rapidly, relatively, than the pest, and partly to the spreading of the pest in each plot and to neighbouring plots in the earlier part of the season. It is not until the end of the season, when the output of bolls is diminishing and the pest has distributed itself much more uniformly, that any extensive multiplication in one place can occur. For these reasons the extent of damage indicated by the figures already tabulated is to be regarded as the maximum possible in existing conditions at one time, and is in no way representative of the season as a whole.

The precise assessment of the damage done by *P. gossypiella* is a matter of great difficulty and is not at present possible in Uganda. The percentage infestation of bolls is everywhere so small, except at the end of the season, that any data which may be collected have no accurate statistical value. It is, however, evident that even the most severe damage recorded in the 1935-36 season, namely, infestation of 15% of the bolls in West Nile, represents exceedingly little loss of crop; for when the infestation amounts to only 15% of the bolls, the great majority of attacked bolls contain only one larva, and the seeds and lint destroyed by one larva are equivalent to not more than one loc, or a quarter of the average boll. Thus, the actual loss of crop, corresponding to 15% infestation of bolls, does not exceed 4%. Moreover, this extent of damage occurred only at the extreme end of the season, all previous pickings having been almost entirely free from *P. gossypiella*. It is likely, therefore, that the damage to the crop as a whole did not exceed 1%, and in all other parts of the country the damage was less than in West Nile.

General observations have shown that so long as the percentage of bolls attacked does not exceed about 20, the number of larvae per boll seldom exceeds one. So long as this is the case, the damage to each boll is not greater than that already indicated. A single larva of *P. gossypiella*, unlike *Argyroproce leucotreta*, feeds comparatively cleanly and rarely attacks the base of a boll, and it causes very little rotting and staining of the lint as a rule. The quality of the lint in unattacked locs of attacked bolls does not appear to be appreciably affected, judging from field observations, except in the case of bolls attacked when small and in the case of bolls containing more than one larva.

The attack of *P. gossypiella* upon buds, flowers, and very young bolls is serious only in those few plots in which the infestation becomes severe considerably before the end of the season. In the great majority of plots it is not responsible for any appreciable loss in existing conditions.

An important point which is clearly brought out by the tabulated figures is that the extent of the infestation is, on the whole, considerably greater in the hotter, drier areas than in the cooler, wetter ones. This suggests that climate is an important factor, but a closer consideration of the available facts points to a different conclusion. If there were any evidence to show that the resting stage occurred on a large scale and that the resulting moths emerged when the cotton was already well advanced, then the greater severity of the attack in areas such as Gulu and West Nile would be attributable to climate. Actually, the available evidence indicates that the resting stage is a rare phenomenon in Uganda and that the resulting moths are, in any case, likely to emerge before the plants are sufficiently advanced for their requirements. Moreover, the alternative host plants do not provide an explanation, for they are even less important in the dry areas than in the wet. The true explanation appears to lie in the degree of thoroughness with which the cotton plants are destroyed at the end of the season. In most of Buganda the destruction is thorough and satisfactory. In the Northern Province it is much less thorough. This point is further discussed in Section VII of this report. It is desirable to add here, however, that Buruli, a hot, dry area, is an exception (see table) to the rule that the infestation is more severe in the hotter, drier parts of the country, and this is probably attributable to the fact that the cotton plots in Buruli are relatively few and far between, being separated by very extensive areas of bush. In these circumstances the chances of survival of *P. gossypiella* are remote. It is also likely, though not definitely known, that the uprooting is more thorough in Buruli than in Gulu and West Nile, because the Buruli plots appear to be more definitely outlined and are more localised, in which circumstances plants are less likely to be overlooked.

It is necessary to bear in mind that the conclusions already outlined as to the extent of damage are based upon observations made during a short period only. The writer has seen only one complete year in Uganda and, although all the evidence indicates that the insect has attained a condition of equilibrium over the greater part of the infested area, it is still necessary to regard it with suspicion and to regard the conclusions drawn to date as tentative only. Moreover, the terminal period of the 1935-36 season, having been abnormally wet, is not to be considered typical in all respects. There is also no doubt that an exceptionally hot, dry season extending to include the beginning of the next season would cause an unusually severe outbreak of *P. gossypiella* in the latter season by increasing the number of resting larvae and prolonging the resting stage. It may, however, be stated that there is at present no reason to regard *P. gossypiella* as a serious menace in Uganda in normal years or in abnormally wet years.

VI. MEANS OF SPREADING.

In countries where the resting stage is a normal occurrence a most important factor in spreading is the transporting of cotton seed containing resting larvae. In Uganda, however, the resting stage is a very rare occurrence, and the examination of large quantities of seed and seed cotton in ginneries, stores, and native markets in both the dry and the wet districts at the end of the last two seasons has failed to reveal any resting larvae whatsoever. The comparatively rapid spreading which has occurred in Uganda, therefore, cannot be attributed to resting larvae.

Nevertheless, throughout Uganda larvae and pupae are present in cotton seed and seed cotton. They are normal short-cycle individuals which are not quite fullgrown when the cotton is picked and are therefore taken to markets, stores, and ginneries with the raw cotton. They are rare, but they are nevertheless to be found by careful searching in baskets of cotton carried as head loads, in sacks of cotton on lorries, on the floors of ginneries amongst cotton seed, and in heaps of seed cotton in sheds. Many of them are killed in the gins, but a few pass through without damage, and others never reach the gins because they withdraw from the raw cotton to pupate before ginning takes place. Moths emerge from them within a fortnight.

These individuals are far too rare to affect the severity of the attack in the next season, and most of them must, in any case, die without progeny because they emerge after the cotton has been uprooted. The earlier ones, however, have time to produce one generation before uprooting takes place, and although this generation does no appreciable damage it serves to establish the species in new localities.

There can be no doubt, also, that the moths themselves are sometimes carried long distances in lorries, buses, river steamers, and other vehicles, though they have not actually been seen in any except river steamers. The moths shelter at dawn in any dark crevice or corner and many suitable places are available on lorries and buses. On steamers, the moths, in addition to sheltering at dawn, are attracted by the lights at night, and 2 females were seen recently at lights on s.s. "Coryndon" during a journey from Pakwach to Butiaba.

Thus, we may conclude that the normal spreading of the moths by their own powers of flight is supplemented by human agency. It is impossible, however, to estimate the relative importance of artificial and natural spreading. A recent record from America, of moths of *P. gossypiella* caught by an aeroplane at an altitude of 3,000 feet suggests many possibilities. The evidence, though scanty, is at least sufficient to show that *P. gossypiella* must be expected to reach all cotton-growing areas of Uganda within a few years. In fact, it is most likely that the insect has already reached all cotton areas but has not yet succeeded in establishing itself everywhere, notably in Teso. In view of the comparative thoroughness of the destruction of the old cotton in Teso and the almost complete lack of alternative host plants, the chances of the species establishing itself from a few isolated moths are not great. Sooner or later, however, its permanent existence in Teso is to be expected, and the apparent immunity of Teso to date is to be attributed at least as much to the unsuitability of the area for the insect, on account of a rigid dead season, as to regulations prohibiting the movement of cotton into Teso.

VII. CONTROL.

The climatic conditions prevailing in Uganda are clearly very well suited to the requirements of *P. gossypiella*, and if food were available for it throughout the year there can be no doubt that it would multiply so greatly and maintain so high a population as to cripple the cotton industry very severely. But the existing practice of enforcing a rigid dead season for cotton checks, to a very great extent, the activities of the insect and is itself an admirable control measure. The duration of the cotton season, as at present regulated, is short enough to prevent serious damage. It is, however, only just short enough, and this is a point which cannot be too strongly emphasized. If it were one month longer the damage done would be very great and would involve a considerable proportion of the season's crop. The adjustment is a delicate one, and one which can easily be upset by any factor which can favour the pest by increasing its numbers at the beginning of the season or extending the duration of the season.

There are only three means by which *P. gossypiella* can survive the dead season. These are alternative host plants, the resting stage, and cotton left standing. The account already given of the alternative host plants shows that they are not a serious factor, and that in a large part of the Protectorate they are not a factor at all. In the wetter parts of the country the destruction of *Hibiscus macranthus* is a theoretical means of reducing the extent of survival of *P. gossypiella*, but this possibility has been given due consideration in the field and has been found to be impracticable on a sufficiently large scale. In any case, no such measure is at present justified by the very small amount of damage which has so far occurred in the wetter areas and which, on present evidence, seems likely to continue.

The resting stage, as a means of surviving the dead season, is in many countries of the greatest importance. It is passed in the seed, in the soil, and in a variety of other situations. One of the most important control measures in countries where the resting stage is a usual or regular occurrence is the subjection of the seed to heat, either in suitable machines or by the sun. In Uganda, however, resting larvae are very rare and occur very irregularly. Except for an occasional short-cycle larva or a pupa, belated as regards the stage of the boll in which it has fed, resting larvae are the only stage of the insect which is ever present in seed. The short-cycle larvae and pupae are often killed in the gins, and those which survive are numerically negligible by comparison with those individuals which survive by other means, notably in cotton plants which have not been uprooted. In these circumstances, measures directed against resting larvae are not warranted, and the destruction or treatment of seed is of no avail from the point of view of the control of *P. gossypiella*.

There remains only the possibility of the insect surviving the dead season in cotton plants which, contrary to regulations, have not been uprooted. The degree of thoroughness with which the uprooting is carried out depends to a large extent upon the distinctness of the boundaries of the plots. In the wetter parts of the country the plots are usually very clearly defined, being bounded by elephant grass, plots of other crops, or tall, mixed vegetation. The thorough uprooting of all plants in such plots is an easy matter. In the drier areas, on the other hand, the cotton plots are commonly surrounded by short grass

and open bush, and the grass tends to encroach upon the plots as the season advances. The plots, moreover, are often of irregular shape. In these circumstances, and particularly in plots far removed from main roads, it very frequently happens that some of the plants growing on the periphery, where the cotton merges with the surrounding vegetation, are not uprooted. These plants, which often survive the dry weather which usually prevails during the dead season, although they suffer severely from it, enable the insect to carry over to the next season. In the course of a recent safari in Gulu and West Nile, the writer noticed many plants which were undoubtedly survivors from the previous season, and some of them were now entirely surrounded by bush owing to shifting cultivation. It is also not unusual, particularly in Gulu and West Nile, to see cotton plants, derived from accidentally dropped seed, growing in bush at the sides of native tracks, sometimes far from cotton plots. This is less frequent in the wetter areas because the more intensive cultivation results in better control of crops. Dropped seed is a very common source of isolated cotton plants in and around ginneries compounds and, to a lesser extent, near native settlements, and in such situations it is unusual for any attempt to be made to seek out and destroy the plants. For this reason (and not because the insect has undergone a resting stage, as is commonly supposed) cotton plots in the neighbourhood of ginneries are almost invariably more severely attacked than most others, and this applies to all parts of the country. Isolated plants are also to be seen at ferries and riverside ports, such as Atura, Laropi, Rhino Camp, and Pakwach.

It is exceedingly difficult to ensure the uprooting of these isolated plants, since all but a few can only be found by searching. It is also difficult to ensure really thorough destruction of plants at the edges of plots in short grass country. Until this is done, however, the severity of the attack will always be greater in Gulu and West Nile than elsewhere, and ginneries, ports and other similar places where raw cotton is handled in bulk, will continue to be centres of infection. It must be admitted that the present small amount of damage done by *P. gossypiella* does not seem to warrant any great efforts in this direction, but it must be remembered that the margin of safety is small and only exists in a normal year. An abnormally dry and hot season might have disastrous results in the drier districts if other conditions were unchanged, and it is, therefore, most desirable to attempt, particularly in Gulu and West Nile, to ensure more thorough cleaning-up of the cotton at the end of each season. This cannot be done suddenly, but it should be possible in the course of time. In the wetter districts, the uprooting is done very thoroughly and satisfactorily, on the whole, but it is most important that the present high standard should be maintained, and to this end annual reminders are probably desirable.

The serious consequences of failure to uproot cotton at the end of the season have been clearly demonstrated recently in two localities near Kampala. At the end of the 1934-35 season these two plots were not uprooted and the cotton persisted throughout the following dead season. *P. gossypiella* was common in both, and early in the dead season the infestation amounted to 45% and 25% of the bolls, many of the bolls in the more heavily infested plot containing more than one larva. By this time, however, the very dry weather which had prevailed for some time had caused a great reduction in the yield of bolls, and soon afterwards the demand for bolls by *P. gossypiella* exceeded the supply and all bolls, and also many buds and flowers were then infested. The very heavy infestation of buds and flowers which soon followed resulted in almost complete absence of large bolls, and excessive shedding of buds, flowers, and young bolls was caused by the larvae. Thus there arose an interesting condition in which a large proportion of the *P. gossypiella* population was transferred to the ground as immature larvae. Many of the larvae of this ground population undoubtedly died, but many others were found to survive by wandering over the ground and attacking other flowers and buds which fell from the plants. By the beginning of the next cotton season the population in these 2 plots had become greatly depleted, but the pest was nevertheless still present in considerable numbers. Neighbouring cotton plots of the 1935-36 season were at once infested, and the percentage infestation of bolls on October 8th, November 8th, December 16th, and January 25th, was approximately 3, 10, 46, and 70 respectively. The last figure was maintained to the end of the season. This severe attack was not equalled or even approached anywhere else in Buganda. The only other plots in the whole country found to be attacked to a similar extent were at Rhino Camp and on Butiaba Flats, and in both of these localities there was strong evidence that a little cotton had been standing from the previous season. There can, therefore, be no doubt that thorough destruction of the old crop is exceedingly important as a means of ensuring that only a few plots are infested at the beginning of the season and that the *P. gossypiella* population is initially so small that the insect cannot multiply sufficiently to attain a state of general abundance before the end of the season.

An additional means of safeguarding the crop from *P. gossypiella* is the shortening of the season by the introduction of a more rapidly maturing variety of cotton. From the point of view of pests this is highly desirable, and if not undesirable or impracticable from other points of view it is to be strongly recommended. It would, incidentally, reduce the damage done by *Argyroploce leucotreta*, possibly very considerably. *A. leucotreta* is at present doing much more damage than *P. gossypiella*.

The great discrepancy between the number of eggs laid by *P. gossypiella* and the number of larvae found demonstrates clearly a heavy mortality in the newly-hatched larvae. This is very evident in Uganda, and it has been commented upon by other investigators in other countries. The larvae appear to perish in large numbers in the attempt to penetrate the boll wall, and further mortality occurs just after penetration. This suggests the possibility of varietal resistance in cottons to the attack of *P. gossypiella* and possibly *A. leucotreta*, the resistance depending upon the degree of toughness or thickness of the boll wall.

The possibility of control by parasites, should further control prove necessary, has been given some attention. The somewhat scanty knowledge so far obtained of the existing parasites in Uganda suffices to show why they are ineffective (Section IV) and to indicate the type of parasite required in Uganda conditions. In view of the relatively slight damage at present done it is unnecessary to pursue the matter further in this report, except to add that about 60 different parasites of *P. gossypiella* have been recorded from different parts of the world and that none of these seems particularly likely to satisfy Uganda requirements.

In conclusion, it may be said that satisfactory control of *P. gossypiella* in Uganda is apparently to be obtained by the rigid enforcement of a close season and the shortening of the cotton season as far as possible. The evidence at present available indicates that this will be sufficient.

T. H. C. TAYLOR.

ALTERNATIVE HOST PLANTS OF *P. GOSSYPIELLA* IN UGANDA.*

From the beginning of the present investigation, much time has been devoted to the collection and study of the numerous possible alternative host plants of *P. gossypiella* in Uganda. The Protectorate is relatively rich in Malvaceae, in which family alternative host plants were most likely to be found. Attention has been concentrated upon this family, but allied families of the order Malvales (Sterculiaceae, Bombacaceae, and Tiliaceae) have also received attention; and a great variety of other plants, belonging to widely separated orders, have been suspected as possible host plants from time to time and have been investigated accordingly.

The alternative host plants recorded in other countries belong to the following families and genera:—

Malvaceae :—

Hibiscus, *Hibiscadelphus*, *Abutilon*, *Althaea*, *Sida*, *Fugosia*, *Thespesia*.

Tiliaceae :—

Corchorus.

Of these, *Hibiscus*, *Abutilon*, *Althaea*, *Sida*, and *Corchorus* are represented in Uganda. This relatively short list leads at once to the conclusion that *P. gossypiella* is distinctly specialised in its choice of food plants, and in view of the great attention which has been paid to *P. gossypiella* in many parts of the world it is most unlikely that many host plants remain unknown. Moreover, the majority of known host plants belong to the genus *Hibiscus*, which is very closely allied to cotton, and consequently the study of this genus formed the basis for the survey of host plants in Uganda.

Plants of the genus *Hibiscus* are far more plentiful and more generally distributed in the wetter parts of Uganda than in the dry parts, and the species of the wet districts are, for the most part, distinct from those of the dry. For our present purpose the term "wet districts" is used for those parts of the country which have no very marked, hot, dry season, namely, south Mengo, Entebbe, Mubende (except north-east), Toro, south-west Bunyoro, and south Busoga; and the term "dry districts" is applied to those parts of the country which have a marked and prolonged hot, dry season, namely, Teso, Lango, Chua, Gulu, West Nile, most of Bunyoro, north Mengo, and north Busoga. The distribution of the annual rainfall through the year, rather than its actual amount, is the important point. The habitats of the various species of *Hibiscus* are clearly important from the point of view of *P. gossypiella*, since those which flourish in the neighbourhood of cotton plots are more likely to serve commonly as host plants, if otherwise suitable, than those in forests and permanent swamps. It is convenient, therefore, to arrange the species in groups (five in number) according to habitat. In the following list† of the species known to the writer in Uganda, this arrangement is followed, and brief notes on the distribution and occurrence of each species are appended. One species (*H. cannabinus*) falls into two groups.

I. Species Associated with Cultivated Land or Themselves Cultivated.

1. *H. cannabinus*.—Common throughout Uganda on or near cultivated land, roads, and native paths, but usually isolated plants only. Not in bush, except in or near swamps in otherwise dry districts.
2. *H. asper*.—Abundant and semi-cultivated in Teso, Lango, Chua, Gulu, Bunyoro (except south-west), and West Nile. Not in bush or swamps.
3. *H. esculentus*.—Frequent throughout Uganda, but more so in Gulu and West Nile than elsewhere. Semi-cultivated. Not in bush or swamps.
4. *H. sabdariffa*.—Cultivated land in wetter districts. Uncommon.

II. Forest Species.

5. *H. surratensis*.—Common in wet districts only. Extremely rare in Teso and Lango, in shade beside streams. Apparently absent throughout Gulu, Chua, and West Nile.
6. *H. calyphyllus*.—Common in wet districts only. Typically a dense forest species, but common in stunted form in S. Busoga on and near cultivated land. Absent throughout the drier districts.
7. *H. rostellatus*.—Common in dense forest in wet districts. Very rare, in shade of big trees in swamps, in Teso, Lango, and Chua. Absent in Gulu and West Nile.
8. *H. jatrophaeifolius*.—Dense forest in wet districts only. Rare.

III. Swamp Species.

9. *H. diversifolius*.—Mainly confined to permanent swamps in the wetter districts, where it is abundant. Present, but very rare, in Teso, Lango, and Gulu, in papyrus at edges of lakes and streams. Absent in Chua and West Nile.

*The identification of most of the plant species mentioned in this section is tentative only, pending confirmation by the authorities in England.

†The common garden *Hibiscus*, *H. rosae-sinensis*, is not included in this list. It is not attacked by any species of *Platyedra*.

10. *H. panduriformis*.—Seasonal and permanent swamps in dry districts, but rare and local. Seen in north Busoga, Buruli, and Lango. Absent in wet districts.

[1]. *H. cannabinus*.—Abundant in swamps in drier districts, Teso, Lango, Chua, Gulu. Absent in swamps in wetter districts. (See Group I).

IV. Species in Open Bush in Drier Districts.

11. *H. aponeuros*.—Uncommon and local, but present in all drier districts, including West Nile.

12. *H. aethiopicus*.—Rare. Teso, West Nile.

13. *H. physaloides*.—Rare. West Nile.

14. *H. sp. nr. crassinervis*.—Rare. Karamoja (A. M. Gwynn) and Buruli.

15. *H. sp. nr. calyphyllus*.—Rare. Karamoja (A. M. Gwynn) and Bunyoro (Butiaba flats).

16. *H. micranthus*.—Widely distributed and locally abundant throughout drier districts.

17. *H. sp. nr. micranthus*.—Rare. Karamoja (A. M. Gwynn).

18. *H. vitifolius*.—Widely distributed throughout drier districts, but seldom common. Occasionally occurs in wet districts.

19. *H. calycinus*.—Common on old termite hills (not elsewhere) in Teso, Lango, Chua, Gulu, Buruli, and N. Busoga, in shade of taller bushes. Absent in wetter districts.

20. *H. gossypinus*.—Widely distributed throughout all drier districts. Occurs, but much more rarely and locally, in wet districts.

V. Species Growing in Elephant Grass, at Edges of Forest, etc., in Wetter Districts.

21. *H. ludwigii*.—Rare.

22. *H. macranthus*.—Common throughout wetter districts, except S. Busoga. Entirely absent in drier districts, including N. Busoga, Buruli, and Bunyoro (except south-west end). Frequently near cultivated land, but not on it.

There are several species in this somewhat extensive list which cannot serve as host plants for *P. gossypiella* because their fruits are too small. The larvae do not migrate from one fruit to another and consequently require relatively large fruits. These species are *aponeuros*, *aethiopicus*, *sp. nr. crassinervis*, *micranthus*, *sp. nr. micranthus*, and *gossypinus*. With the exception of *aethiopicus*, these are the species which have small, spherical fruits and cottony seeds. The fruits of *aponeuros*, *micranthus*, and *gossypinus* have been examined in large quantities and from many localities and have never been found to contain any species of *Platyedra*. The other three of these six species of *Hibiscus* are rare, and it has not been possible to obtain their fruits in quantity for examination. Nevertheless, it may safely be assumed that they are unsuitable as host plants for *Platyedra*. Thus, these six species, all of which are in Group IV, can be eliminated.

The fruits of all the other species (16 altogether) are large enough for the requirements of *P. gossypiella*. Six of these, namely, *sabdariffa*, *jatrophaefolius*, *panduriformis*, *physaloides*, *sp. nr. calyphyllus*, and *ludwigii*, are uncommon or rare, but it has been possible to obtain the fruits of all of them in some quantities for examination. *H. sabdariffa* and *panduriformis* are attacked by other species of *Platyedra*, but none of them has been found to harbour *P. gossypiella* although all of them have been collected from localities close to cotton plots infested with it. In any case, these species, on account of their rarity, cannot be of importance as alternative host plants.

The fruits of the remaining ten species, all of which are common, have been examined in very large quantities and from many different localities. Three of them (*surratensis*, *calyphyllus*, and *rostellatus*) are forest species, and while these three commonly yield other *Platyedra* spp., *P. gossypiella* has never been obtained from them. There is, moreover, good reason to believe that *P. gossypiella* does not frequent forests. The two remaining species in Group IV, *vitifolius* and *calycinus*, have not been found to be attacked by any species of *Platyedra*. *H. calycinus*, however, cannot be said to have been sufficiently investigated yet. The areas in which it occurs most commonly are those to which *P. gossypiella* has not yet spread, namely, the drier parts of Teso, including Usuku; and in these circumstances its status as an alternative host plant cannot be estimated. The predominant species of Group III, *diversifolius*, has been very thoroughly examined and has never yielded *P. gossypiella*, although it is the principal food-plant of another species of *Platyedra*. In Group I, three species remain to be discussed, namely, *cannabinus*, *asper*, and *esculentus*, and to all of these much attention has been paid. The fruits of *asper* were collected in very large quantities in Gulu and West Nile at the end of the 1935-36 cotton season from plants growing in cotton plots known to be infested with *P. gossypiella*. No trace of any species of *Platyedra* was found in them in these districts, however, despite the fact that the neighbouring cotton, particularly at Attiak, was by this time ceasing to produce buds and bolls in quantity, so that many of the moths of *P. gossypiella* must have had difficulty in finding suitable sites for oviposition. At Lira, earlier in the season, a single larva of another species of *Platyedra*, was obtained from *H. asper*. *H. esculentus* and *H. cannabinus* have both been found to be attacked by *P. gossypiella*, although only as an excessively rare event. The former was recorded as a host plant by Hancock who obtained larvae from it at Attiak (Gulu). Also, it is well known as a host plant in other countries. The writer, on the other hand, has examined large quantities of its fruits from plants growing in cotton plots severely infested with *P. gossypiella* in Gulu, West Nile,

and Buganda, not only while the cotton has been present, but also just after it has been uprooted, and has never found any trace of *P. gossypiella* in them. There can be no doubt that, even though *esculentus* is occasionally attacked, the event is so rare as to be negligible. *H. cannabinus* has yielded only a single individual of *P. gossypiella*, and this was obtained in one fruit of a large number collected from a single large plant growing in a cotton plot at Kampala at the end of the 1934-35 season. The cotton plot was severely infested with *P. gossypiella*. The fruits of many other *cannabinus* plants growing in similar situations elsewhere, however, have proved not to be attacked, and the conclusion for this species is the same as that for *esculentus*, namely, that it is wholly unimportant as an alternative host plant for *P. gossypiella*.

Only *macranthus* now remains, and this is the only species which has been found to be attacked at all frequently by *P. gossypiella*. It is the normal food-plant for another species of *Platyedra*, whose larvae are always abundant in its fruits, and it is also attacked by *P. gossypiella*, although only to a very small extent by comparison. When cotton is present, *P. gossypiella* is exceedingly rare in *macranthus*, but is nevertheless to be found occasionally in it throughout the cotton season; but when the cotton is uprooted, a sudden increase in the population of *P. gossypiella* in *macranthus* fruits takes place, and is very marked, being due to the fact that the moths present when the cotton is uprooted are then forced to concentrate upon neighbouring plants of *macranthus*. The fruits of *macranthus* provide enough food for *P. gossypiella* larvae, particularly because they are very commonly attacked by a gall-forming Cecidomyid fly which causes remarkable proliferation of the tissues of the fruits, so that attacked fruits attain a size equal to, and often exceeding, that of large cotton bolls. One of these swollen fruits often contains many *Platyedra* larvae. The same Cecidomyid attacks the fruits of *ludwigii*, *diversifolius*, and *cannabinus* also. The fruits of *ludwigii* swell to a great size as a result of its attack, but those of *diversifolius* and *cannabinus*, although sometimes distorted, do not swell.

This survey of the species of *Hibiscus* in relation to *P. gossypiella* has thus shown only 3 species (out of 22) which are alternative host plants, and only a single species which is attacked at all frequently. It is probable that certain other species are occasionally attacked. The fact that only a single larva has been obtained from the very common *H. cannabinus* suggests that the other species may also be attacked, but so rarely that the chances of finding the larvae in them are exceedingly remote. A study of the structure and general form of the fruits of the various species, and of their habitats, leads the writer to conclude that 3 species, in addition to those already known to be attacked, may occasionally be attacked. These are *calyphyllus*, sp. nr. *calyphyllus*, and *calycinus*. However this may be, it is quite certain that only *macranthus* is of any importance in this respect, the attack of *P. gossypiella* upon any other species being so rare and irregular, even when the cotton is uprooted, as to be negligible.

The species in Groups II and III cannot, in any case, be important from this point of view because their habitats are localised and are, in general, remote from the majority of cotton plots. The species of Group IV, with the exception of *calycinus*, are all either too rare to affect the issue or unsuitable for *P. gossypiella* on account of the small size of their fruits, if on no other account. *H. calycinus* itself, although described as common, is nowhere abundant or concentrated, and it does not fruit profusely as do many other species. If it were attacked, and if it fruited throughout the year, it might enable *P. gossypiella* just to survive, but it could not do more. Thus, in dry scrub country (Teso, Buruli, Chua, Gulu, West Nile, etc.), none of the species of *Hibiscus* there present is to be regarded as important in this respect. Group I, which was the group at first thought to be dangerous on account of the close association of its species with cultivation, is now known to be unimportant, although two of its species are known to be attacked. Group V alone is of importance, and only *macranthus* in Group V. *H. macranthus*, however, is very strictly confined to the wetter parts of the elephant grass zone. It is a perennial plant which requires heavy rainfall for a long period for germination and which cannot survive long periods of complete drought. Thus, it may be said that in the wetter parts of Buganda *P. gossypiella* has only one effective alternative host plant among the *Hibiscus* species, and that in all the rest of the Protectorate it has no effective alternative host plants among them.

An alternative host plant is important only if it enables the pest to survive the season when there is no cotton. Throughout the drier areas of Uganda all species of *Hibiscus* (except those of the permanent swamps) die back to a greater or lesser extent, and most of them cease flowering completely, during the hot, dry months when there is no cotton. *H. esculentus*, which is known to be attacked by *P. gossypiella* and which is commonly associated with cotton, has its period of flowering and fruiting during the cotton season in a normal year and dies at about the time when the cotton is uprooted. *H. calycinus*, which may be attacked by *P. gossypiella* though it probably is not, ceases flowering to a large extent at the end of the cotton season. This fact renders the potential alternative host plants still less important in these cases. In the wetter districts, on the other hand, *H. macranthus* (with other species) continues flowering and fruiting during the time when no cotton is present, in a normal year. That is to say, it enables *P. gossypiella* to survive the dead season and to be present when the next crop of cotton appears.

The survival of the pest in *H. macranthus*, however, is fortunately offset by another circumstance. *P. gossypiella* shows a very marked preference for cotton, and when cotton is present it very rarely attacks any other plant, even *H. macranthus*. When the cotton is uprooted it attacks *macranthus* commonly, but only for one generation. After about a month, even *macranthus* is invariably found to be attacked only very slightly, no more severely, in fact, than when cotton is present, and this condition continues during the remainder of the dead season. In the 1935 dead season, *P. gossypiella* disappeared completely in several localities where *macranthus* flourishes and where special observations were made. It survived in the area as a whole, but locally it disappeared so that the next season's cotton was initially free from it locally, despite the presence of *H. macranthus*. This is solely attributable to the strong preference of

the pest for cotton. The moths which have already begun ovipositing when the cotton is uprooted and destroyed cannot spread far and tend to concentrate on *macranthus*. The moths which result from this *macranthus* generation, however, leave the plants from which they have emerged and spread in all directions from them, seeking cotton. Since there is a preoviposition period of 3 days, they may spread long distances before they require to begin ovipositing, and in any case oviposition on *macranthus* occurs only as a last resource. Thus it is not surprising to find that in some localities *P. gossypiella* disappears completely, and that it cannot anywhere survive the dead season in large numbers in *H. macranthus*.

The examination of *Hibiscus* spp. for *P. gossypiella* is complicated by the presence in Uganda of 4 other species of *Platyedra* the larvae of which are very similar to one or other of the forms of *P. gossypiella*. Extreme care is, therefore, necessary in the identification of any larvae which may be found.

The many other plants which have been examined as possible food-plants for *P. gossypiella* can be dealt with briefly, as none of them has been found to harbour the pest. The other genera of Malvaceae which have been examined thoroughly in various parts of the country are *Abutilon*, *Urena*, *Kosteletzkya*, *Pavonia*, and *Sida*. Two of these (*Abutilon* and *Sida*) contain species which have been recorded as host-plants elsewhere. *Abutilon* fruits are severely attacked in Uganda by *Crociosema plebeiana*, which attacks several species of *Hibiscus* also, but none of the species of *Platyedra* which feed on *Hibiscus* ever attacks *Abutilon*. The other four of these five genera have similarly proved to be entirely free from all species of *Platyedra**.

In the Tiliaceae, the genera containing species formerly thought likely to be attacked by *Platyedra* are *Corchorus*, *Triumfetta*, and *Glyphaea*. These, however, have proved not to be attacked by any species of *Platyedra* in Uganda, judging from the extensive examination of them which has already been made. The genus *Corchorus* contains species which have been recorded as host plants of *P. gossypiella* in the Sudan, and two species (*C. olitorius* and *C. trilocularis*) are common throughout Uganda, particularly in Busoga and Teso. In view of the Sudan observations, it is possible that *Corchorus* spp. may be attacked in Uganda, but if so the attack is an exceedingly rare and negligible occurrence. The fruits of *C. olitorius* are large enough to provide all the food required by *Platyedra* larvae, but those of *C. trilocularis* are too small.

The family Sterculiaceae contains a few plants which have been regarded as possible alternative host plants. The genera concerned are *Dombeya*, *Melhania*, and *Sterculia*. Two species of *Dombeya*, which are common in the drier areas of Uganda, have been examined very thoroughly. *P. gossypiella* has never been found in them, nor has either of the two indigenous species of *Platyedra* which feed on *Hibiscus*, but a hitherto unknown *Platyedra*, at present unnamed, has been obtained commonly from *Dombeya emarginata*, and from nothing else. The larvae of this species might readily be mistaken for *P. gossypiella*. *Melhania ferruginea*, a common plant in the drier districts, particularly West Nile, has fruits apparently well suited to the requirements of *Platyedra* spp., but it has never been found to be attacked by them. The tree *Sterculia cinerea*, common in the extreme north and extending into Teso, has been found to be attacked by *Earias* sp. ("Spiny Boll Worm" of cotton) but not by any *Platyedra*.

The Bombacaceae include kapok (*Ceiba*) which is grown extensively in some parts of Uganda, notably Gulu and West Nile. A large sample of its fruits, mature and immature, was collected at Attiak at the end of the 1935-36 cotton season in the neighbourhood of cotton plots infested with *P. gossypiella*, but no *Platyedra* larvae were found in the sample. Less extensive samples collected elsewhere in Uganda have also yielded negative results.

The fruits and flowers of a great variety of other plants, shrubs, and trees commonly associated with cotton plots have been examined. The families represented include the Compositae, Labiatae, Melastomaceae, Solanaceae, Leguminosae, and Acanthaceae. It was thought most unlikely that any of these families would yield *Platyedra* spp., and with the exception of the Acanthaceae none of them has done so. *Acanthus arboreus*, however, while never attacked by *P. gossypiella*, has unexpectedly proved to be the normal food-plant of a new species of *Platyedra*, at present unnamed, which has been found as an extreme rarity in cotton, and whose larva very closely resembles that of *P. gossypiella*.

As a result of this survey the opinion has been formed that all of the five species of *Platyedra* in Uganda are exceedingly conservative in their choice of food-plants, even when allowance is made for the remarkable discovery that the species which normally feeds on *Acanthus* does, as a rare event, attack cotton also. This species has never been found in *Hibiscus* or any other plant. Another species is entirely confined to *Dombeya*. Two more species are strictly confined to *Hibiscus*, and each shows very strong preferences for a particular species of *Hibiscus*, the *Hibiscus* species being different in the two cases. That these *Hibiscus*-eating species appear never in any circumstances to attack cotton is itself a remarkable fact. In view of these observations, it is not surprising to find that, in spite of the rich flora of Uganda, *P. gossypiella* is almost without alternative host-plants and that those which do exist barely enable it to survive the dead season for cotton. In the laboratory, the larvae thrive upon the fruits of any species of *Hibiscus* whatsoever and eat them all as readily as cotton, yet for oviposition purposes the moth shows a strong preference for cotton, and, in the absence of cotton, for *H. macranthus*. This contrasts strikingly with the case of *Earias* (Spiny Boll Worm) which has been found in the field attacking all the species of *Hibiscus* in Uganda, without exception, and also *Abutilon*, *Sida*, *Urena*, *Sterculia*, *Melhania*, *Dombeya*, and *Triumfetta*. From this it would be expected that *Earias* can survive the dead season for cotton in infinitely larger numbers than can *P. gossypiella*, and this is borne out strikingly by field observations. So long as cotton is present, the conditions throughout Uganda are clearly ideal for *P. gossypiella*; but as soon as the cotton is uprooted they become extremely adverse.

**Althaea* (hollyhock) has not been examined, but it is rarely grown in Uganda, and is negligible.

NOTES ON OTHER SPECIES OF *PLATYEDRA* IN UGANDA.

The survey for alternative host plants of *P. gossypiella* in Uganda has led to the discovery of 4 other species of *Platyedra*. The larvae of these 4 species and the adult of one of them are easily confused, at first sight, with those of *P. gossypiella*; and for this reason, and also because it seemed desirable to investigate the possibility of their attacking cotton, all of them have been studied to some extent.

Platyedra erebodoxa, Meyr.

This species is very common in the wetter areas of Uganda, but is rare in the drier areas. It has not yet been found in West Nile. Its larva is very common in the fruits of *Hibiscus diversifolius* (in swamps), rather less common in *H. surratensis* and *H. rostellatus*, and rare in *H. sabdariffa*, *H. asper*, and *H. panduriformis*. It does not attack cotton in the field, but eats it readily in captivity, provided the bolls are first cut open.

The eggs are laid singly amongst the spines and hairs on the outsides of the fruits and buds. The larvae feed mainly upon the seeds and commonly complete their feeding upon the ripe seeds after the fruits have burst open. When fullgrown the larvae usually enter a resting stage, the duration of which varies from 1 to 4 months and possibly more. The resting stage is spent in the emptied locs, which are closed by the larvae with dense white webs. Unlike that of *P. gossypiella*, it occurs in the wettest and coolest parts of Uganda as well as in the drier and hotter areas and is to be regarded as a normal procedure for this species. Both field and laboratory observations, however, have shown that by no means all the larvae enter the resting stage and that those which do so are, for the most part, those which have fed mainly on ripe seeds. Larvae in fruits of *H. surratensis* rarely enter a resting stage, and this appears to be associated with the fact that the fruits of this species develop more slowly so that the larvae mature before the fruits are ripe and dry. Similarly larvae fed upon immature cotton bolls do not rest. It has been found, also, that the resting stage can be terminated by high humidity, and that if moisture is not provided within about 5 months the larvae die. These observations suggest that the cause of the resting stage is associated with the water content of the food and that the period of resting is terminated by wet weather. It seems probable that the resting stage serves to enable the species to survive periods when the plants are not flowering.

Pupation takes place in the fruits, never in or on the soil. The adult of this species is similar in appearance to that of *P. gossypiella*, but is readily distinguishable on close inspection.

Platyedra cunctatrix, Meyr.

P. cunctatrix is abundant in most of the wetter districts of Uganda, its distribution coinciding with that of its principal food plant, *Hibiscus macranthus*, in the fruits of which it is always plentiful. It is also to be found, but rarely, in fruits of *H. calyphyllus* and *H. diversifolius*. It appears to be entirely absent in the hotter districts, and it does not attack cotton, except when provided with immature bolls in captivity.

The eggs are laid singly on the developing fruits and the larvae feed in the fruits upon the seeds and are fullgrown before the fruits are ripe. Pupation takes place within the fruits, the larvae first making exit holes which they partially close with cone-shaped silken covers. The life cycle covers 35 to 40 days. A resting stage never occurs in this species, and in this respect the habits of *P. cunctatrix* differ strikingly from those of *P. erebodoxa*, which is commonly to be found in the same localities, but not in the same species of *Hibiscus*. It is noteworthy that in normal years *H. macranthus* flowers continuously, so that there is no need for a resting stage in insects which feed on it.

Platyedra sp. I.

This species appears to be widely distributed in the wetter districts. Its normal food consists of the ripe seeds of *Acanthus arboreus*, which are very hard. It also attacks cotton, but only very rarely, and it has been found in cotton at Kampala only, although a constant watch has been kept for it in other parts of Uganda. Reports from Tanganyika, however, indicate that it is not uncommon there in cotton. The larva feeds in large, but immature, cotton bolls, and also in ripe, open bolls in exactly the same manner as that of *P. gossypiella*, which it very closely resembles. This species does not undergo a resting stage and has never been found to attack *Hibiscus* or any plants other than *Acanthus* and cotton, which is remarkable. Pupae have been found in open cotton bolls.

Platyedra sp. II.*

This insect appears to feed only upon *Dombeya* spp., principally *Dombeya emarginata*, and it is therefore confined to the drier districts. It is particularly common in the eastern part of Mubende District. The larva feeds inside the buds and apparently does not attack the fruits. It almost invariably enters a resting stage when fullgrown, and the resting larvae, when kept in the laboratory, always die after about 5 months unless subjected to high humidity, which induces them to pupate. *Dombeya emarginata* has clearly defined flowering seasons, and the resting stage obviously serves to enable the insect to survive the periods when buds are not available.

*The generic determination of this insect is provisional only. Specimens have been sent to the British Museum.

Means of Distinguishing the Larvae of *Platyedra* spp. in Uganda.

The discovery that *Platyedra* sp. I occasionally attacks cotton suggests that one or more of the other species may be found to do so in the future. Moreover *P. gossypiella* is occasionally present in the fruits of the wild food-plants of other *Platyedra* spp.. It is, therefore, essential that the larvae of the various species should be distinguished with certainty.

The larva of *P. gossypiella* is liable to great variation according to its food. The typical and most common form has clearly marked, transverse, pink bands across each segment, but larvae which have fed on rotting tissues (such as fallen buds and flowers in wet weather) are often entirely devoid of pigment and are semi-transparent. The appearance of these larvae is very different, in extreme cases, from the typical form. Another feature which is liable to considerable variation is a pair of kidney-shaped spots on the dark brown prothoracic plate, one on either side. These are usually whitish and very distinct, much more so than in any other species, but in some larvae they are scarcely lighter than the rest of the plate, and are therefore hardly visible. Other features vary similarly.

All of these five species of *Platyedra*, with the exception of *cunctatrix*, typically have pink bands across the segments, but those of *gossypiella* are less interrupted than those of the other three. *P. cunctatrix* is never banded. At the bases of the setae all over the body there are strongly chitinated, brown plates, the size of which is nearly constant for each species. In *gossypiella* and *erebodoxa* these are exceedingly minute and inconspicuous, but in the other species they are relatively large, so that the larvae appear spotted. As a general rule, therefore, it is possible to distinguish the larvae by their general appearance, which is due mainly to the presence or absence of pink bands, the degree of continuity of the individual bands, the size of the plates at the bases of the setae, and the degree of distinctness of the kidney-shaped thoracic spots. In view of the variation which has been observed, however, it is necessary also to take into account the arrangement of the crochets on the prolegs, a feature which is, unfortunately, difficult to examine in the field. In all the five species the crochets are uniordinal (*i.e.*, in a single row or arc), and are arranged in an incomplete circle. In all species there is a gap in the circle on the outer side, but in some there is also a gap on the inner side. The number of crochets varies considerably within each species, but when allowance is made for this variation, the number of crochets is a useful additional distinguishing feature.

The following key has been found reliable for distinguishing the larvae of the various species. References in it to the crochets apply to all prolegs except those of the posterior segment.

Key to the Last Instar Larvae of *Platyedra* spp. in Uganda.

- | | | | | |
|----|--|----|----|-----------------------|
| A. | Pink bands (more or less interrupted) across segments | .. | .. | B. |
| | No pink bands, body uniformly coloured or transparent | .. | .. | D. |
| B. | Plates at bases of setae large, so that larva has spotted appearance | .. | .. | C. |
| | Plates at bases of setae small, so that larva not markedly spotted | .. | .. | E. |
| C. | Crochets 15—20, with a gap on outer side only | .. | .. | Sp. I. |
| | Crochets 7—11, with a gap on inner side as well as outer | .. | .. | Sp. II. |
| D. | Crochets with a gap on outer side only, plates at bases of setae small | .. | .. | <i>gossypiella</i> *. |
| | Crochets with a gap on inner side as well as outer, plates at bases of setae large | .. | .. | <i>cunctatrix</i> . |
| E. | Crochets with a gap on outer side only | .. | .. | <i>gossypiella</i> †. |
| | Crochets with a gap on inner side as well as outer | .. | .. | <i>erebodoxa</i> . |

Hybridisation in *Platyedra* spp.

An attempt was made to cross-pair some of the species of *Platyedra*, namely, *gossypiella*, *cunctatrix*, and *erebodoxa*. All possible combinations were tried, and one (♀ *erebodoxa* × ♂ *cunctatrix*) was successful. The hybrid larvae, when fullgrown, were indistinguishable from *cunctatrix*, the species of the ♂ parent. The moths, however, although intermediate in some respects and distinguishable from both parent species, resembled *erebodoxa*, the species of the ♀ parent. In all, 30 hybrid moths were obtained, and these included no gynandromorphs or other abnormalities. Unfortunately, it was not possible to carry the experiment further.

In spite of the ease with which this cross was obtained, and the fact that several species often occur together in the same localities, no indication of the occurrence of hybrids in the field has ever been obtained and it now seems certain that they do not occur.

*Unpigmented form.

†Pigmented form.

ACKNOWLEDGMENTS.

The assistance of many members of the Laboratory and Field Staffs of the Department of Agriculture has greatly facilitated this investigation and is gratefully acknowledged. The writer is particularly indebted to Mr. H. Hargreaves, Government Entomologist, for his advice and criticism in the course of the year's work and also in connection with the present report; and also to Mr. G. L. R. Hancock, formerly Assistant Entomologist, for permitting free use of the observations on *P. gossypiella* which he accumulated from 1931 until he left the Department early in 1935. The Imperial Institute of Entomology has determined many of the insects concerned and has also provided useful information concerning parasites.

ANNUAL REPORT OF THE MYCOLOGIST, 1935.

The Mycologist was on leave in England from May till the end of the year, returning to Uganda in January, 1936. In consequence of this absence, and the fact that all results to May, 1935, were included in the report for 1934, there is little to record here, except preliminary investigations into the problem of Cotton Wilt in Buganda, which have been carried out during the end of the 1935-36 cotton season.

The results obtained in the field on Blackarm disease and varietal resistance thereto are included in the reports of the Botanical Section, under Bukalasa and Serere, the work having been carried out under the supervision of these officers.

COTTON WILT DISEASE.

Within recent years this disease has become of considerable importance in Buganda Province. Up to a few years ago the disease had been recorded here as sporadic cases only, but during the last season or two it has been quite common to find groups of plants showing internal symptoms of Wilt in many native plots. In last year's report it was mentioned that during a tour of inspection in the area around Masaka it was found that most native plots showed signs of infection.

At the beginning of 1936 a detailed examination was made of large numbers of plants growing on Bukalasa plantation, which is known to be rather more heavily infected with this disease than native plots in the vicinity. The results showed that with the variety B.P. 50, inside the infected patches of land very few plants showed no sign of infection, the number of such being of the order of 1—2 per cent. of the total number examined.

There is every reason to expect that this disease will continue to spread among native cultivations in Buganda, and may even appear in other cotton growing areas of the Protectorate. Its effect upon the cotton crop as a whole is at the moment negligible, but in the future we may expect that its effect on the crop will show up more and more, unless we can produce varieties less susceptible to its attack than those at present in general cultivation. As the selection and propagation of such varieties may prove a long process it is important that every effort be made in this direction at present, before the disease has reached the stage of an important limiting factor of our cotton production.

The disease in the field can be diagnosed with certainty only by the examination of the woody tissues of the stem and roots; these show yellow to brown streaks running in a longitudinal direction through them. Many plants show a sudden wilting of the leaves, followed by a browning of the leaf blades, commencing at the margin, between the main veins; these leaves quickly dry up and fall off the plant. Plants of any age or size may show these symptoms, even at a late stage in the season, when they have produced most of their crop.

A more obscure form of the disease is here termed "chronic"; the plants show no obvious external symptoms, and in most cases would be classed as poorly developed; they produce little or no crop. Internally they show the typical Wilt streaks in the wood; in the absence of such streaks the poor development of the plants must be due to other causes such as the soil or climate. The leaves of such plants often show a dried out appearance of the leaf base when pulled off the stem, and yellowish or brown dots visible to the naked eye may in some cases be seen in one or more of the vascular bundles exposed on the surface.

In advanced cases the fungus may be found in the vascular bundles of all parts of the plant, penetrating to the leaves and bolls. In the case of the latter there is a possibility that in some cases the fungus may invade the seed; internal infection of the seed from wilted plants has been demonstrated to occur in the United States of America and in India, in the latter case varying from 0 to 22 per cent. of the total seed produced by such plants. There is no reason to believe that internal infection of the seed does not occur in Uganda; in fact, the spread of the disease in recent years through native plots can be most easily accounted for on this basis.

Infection takes place from the soil; in this it has been proved to recur at Bukalasa after a period of three years between successive cotton crops, and to have spread slightly in the soil during that period. Thus for the future we may expect the disease to show up in greater quantity in native plots where at present it is limited to odd plants; and at the same time to infect plots at present healthy, through the medium of infected seed used for planting.

Under present conditions in Uganda there is little hope of obtaining any measure of control of the spread of the disease. There is no known means of eradicating infection from the soil, once this has taken place; such measures as crop rotation or fallowing have little or no effect upon the extent of infection. The fungi of this and other Wilt diseases can exist as saprophytes in the soil. In other countries where this disease has been serious in the past resistant varieties have been evolved, and this is the most promising line of attack on this disease in Uganda.

At the moment work is being carried out with this in view. For the past three seasons at Bukalasa attempts have been made to grade up the resistance of the local cotton by growing it in a plot in which a large amount of infected debris has been buried in the soil year by year. All plants becoming infected are dug in the soil of the plot, and seed is saved for the following season from plants showing no sign of infection at the end of the year. In this way it is hoped to build up a stock of seed of plants showing resistance to attack, but the problem is complicated by the fact that selection must be carried out on such plants to avoid deterioration in other characters, especially those relating to lint quality and yield.

For the future, in addition to the above, similar work will be carried out using varieties previously selected for yield and quality, and thus attempt to select from such a number of resistant strains.

This field work on the selection of varieties resistant to infection is hampered by the fact that it is extremely difficult to ensure that all plants are exposed to the same risk of infection. Similar difficulty in this matter has been found in Egypt. There is always some risk that plants remaining healthy at the end of the season have merely escaped infection and are not necessarily resistant to it.

In order to supplement this selection on a field scale, a system of inoculation of plants of selected varieties in the laboratory is being evolved. The seed is sown singly in pots, in which the soil has first been sterilised and then inoculated with a pure culture of the Wilt fungus. Plants remaining healthy after some six or seven weeks' growth in the pots will be transferred to the field; as the pots are made of banana fibre, there should be little difficulty entailed in getting the plants to grow in a normal manner after transplanting in the field, as pot and all can be planted, without disturbing the root system of the young plants. This method is still in its infancy in Uganda, as only preliminary tests have so far been possible.

It has been found that the flora of the discoloured streaks found in infected plants in the field is by no means uniform, and a number of different strains of *Fusarium* have been isolated therefrom. These are being tested out for pathogenicity; any strains producing typical Wilt symptoms are being run up in large cultures to provide inoculation material for the selection work referred to above. In this work it is important that all plants be exposed to infection by a number of pathogenic strains of *Fusarium* as there still remains the possibility that plants may prove resistant to one strain and susceptible to another.

The results from the preliminary series of inoculations carried out so far have opened up a number of interesting problems in connection with the process of infection on young plants, though much re-testing of these results will be needed before they can be considered as definitely proved.

In a large number of cases seed of susceptible varieties planted in pots with soil inoculated with the Wilt fungus fail to germinate at all. Microscopic examination of these shows that the tissues inside the seed are invaded by the fungus and a rot is set up affecting first the young root and finally involving all the tissues of the embryo. This has been confirmed in experiments in which seed was sterilised and sown in agar cultures of the fungus.

In many other cases, confirmed in the same manner, germination occurs and the cotyledons appear above the surface of the soil. Little further growth takes place and the seedlings finally die. Examination of these shows that although fair development of the shoot has taken place the root system is almost entirely undeveloped. In agar cultures, where the process can be watched from day to day it is found that in such seedlings the root appears in a normal manner from the seed, followed by the shoot. The main root elongates up to as much as two inches, but the surface soon takes on a dark appearance and finally becomes black. Young side roots appear either at this stage or before, but do not elongate as a rule more than $\frac{1}{4}$ to $\frac{1}{2}$ -inch before they in turn become discoloured on the surface. Examination of the discoloured root surfaces shows that the development of root hairs is almost totally suppressed,

the cells of the surface layer and of the rudimentary root hairs contain a granular dark mass and appear to be killed. The hyphae of the fungus are found ramifying all over the surface of such roots, but have not yet been shown to actually penetrate into the tissues, except at those places where the young side roots emerge through the cortex of the main tap root.

To what extent these processes take place in the field has not been determined, as they have only recently been discovered, and cotton planting is only just commencing (May, 1936).

On susceptible plants which have managed to escape the above two types of infection, more typical Wilt symptoms are shown. In most cases infection occurs on the hypocotyl and partakes of the nature of a "sore shin" disease, hitherto in Uganda regarded as being due to infection by *Rhizoctonia solani*. The infected tissues show at first a reddish tinge on the surface, later changing to dark brown. In many plants attacked in this way the rot involves the whole of the cortical tissues at ground level, and the young plant falls over and dies. In other plants the infection appears to become localised to the surface tissues of one side, and although these are killed, no invasion of the deeper tissues of the cortex and vascular system occurs at this stage. The plants continue to grow, and as the stem becomes thicker, the dead surface tissues split.

Although such plants appear to make complete recovery from the initial attack there is still considerable chance that they may develop the disease at a later stage in their growth. Sudden wilting of the leaves occurs, no previous symptoms on them having first appeared. Examination of these plants shows that the Wilt fungus has at last penetrated into the deeper cortical tissues of the stem and root just below ground level, and has spread in the vascular system up into the main stem for a distance of up to six inches or more before the sudden wilting occurs. The affected parts of the vascular system show a yellow-brown discoloration. This type of infection has so far occurred on plants which have developed some two to six leaves, the cotyledons still remaining green and attached to the plants.

At the moment no information is available as to the subsequent history of plants which survive the forms of attack described above.

The work at present outlined for attack on this Wilt problem in Buganda may be thus summarised:—

(a) An attempt is being made to evolve a more Wilt-resistant stock from local cotton by a process of mass selection of plants remaining healthy when grown on heavily inoculated land.

(b) Attempts to increase the resistance of new varieties selected primarily for market quality and yield, by similar means to (a).

(c) By detailed examination of all varieties grown in an infected breeding plot, to select out individual plants from each variety, for further propagation and selection; with the object of combining Wilt resistance with other desirable characters.

(d) By large scale pot inoculations using seed of a limited number of selected varieties, to attempt to select out on the basis of individual plants, a Wilt-resistant stock of these for further propagation.

(e) As most of the local varieties show little resistance to Wilt under field conditions, a number of varieties are being imported from the United States of America, having the reputation of being resistant to Wilt there. These will be used for selection work and breeding, with the hope that by crossing them with local cottons we shall be able to combine their Wilt resistance with the market qualities of our present types.

As explained above it is important that progress be made in these directions before the disease increases to such an extent in native cultivations as to have a serious effect upon production. There is little or no hope that we can control this spread of the disease on a crop such as cotton, grown by natives in plots scattered over the whole country. The seed originating from wilted plants cannot be separated from that from healthy plants, in spite of our experience in the field that the disease is spread from plot to plot chiefly through the medium of such infected seed. Many plants in the field show obvious Wilt symptoms only at the end of the season, after the crop has been picked, and there is considerable risk that the seed from such was infected.

C. G. HANSFORD,

Mycologist.

BLACKARM RESEARCH, 1935-36. EASTERN DIVISION.

In the absence of the Mycologist on home leave during the 1935-36 cotton season, the following outline report has been prepared.

EXPERIMENTAL RESULTS—DISTRICT VARIETY TRIAL.

A detailed examination of the incidence of Blackarm disease was made in October, 1935, in the twelve District Cotton Variety Trials.

The results of the analysis of the yield figures for these trials will be found in the Assistant Botanist's (Serere) Annual Report.

The varieties included in each of these trials were:—

N. 17. Nyasaland Upland. The standard variety in Lango and Busoga Districts.

S.G. 29. Nyasaland Upland. The standard variety in Teso, Bugwere, Bugishu and Budama Districts.

S.P. 72. Nariama derivative, selected from N. 17 for Blackarm resistance.

S.P. 20. U. 4/4/2 derivative. Selected for high yield, high ginning out-turn and good resistance to Blackarm.

The results are summarised below:—

MEAN PERCENTAGE PLANTS INFECTED WITH BLACKARM LESIONS.

Centre.		S.P. 20.	S.P. 72.	N. 17.	S.G. 29.	Least Significant Difference.
LANGO	Aduku	5.0	19.5	19.0	33.0	8.8
	Kaberaido	1.5	2.0	11.0	25.0	7.4
	Ngetta	6.0	7.5	43.5	59.0	19.2
TESO	Nyero	41.5	56.0	79.0	99.5	7.7
	Serere	63.5	66.0	96.0	100.0	6.2
BUGWERE	Kachumbala	16.0	23.0	46.5	91.0	13.2
	Kibale	24.3	27.3	34.3	49.3	9.2
BUDAMA	Mulanda	17.0	13.5	54.0	78.0	17.7
BUSOGA	Vukula	2.5	3.8	8.0	19.3	5.1
	Bugaya	1.5	1.5	6.8	13.3	5.6
	Bulopa	2.0	2.5	12.0	27.8	7.4
	Iganga	1.0	2.5	2.5	7.8	—
ALL CENTRES		15.1	18.8	34.4	50.2	2.5

Conclusions (all centres):—

1. S.P. 20 < S.P. 72 < N. 17 < S.G. 29.
2. Interaction of Variety × Centre highly significant.
3. The Serere figures are unduly large because of mechanical infection by hail damage.

MEAN PERCENTAGE PLANTS SHOWING BLACKARM LESIONS ON THE MAIN STEM ONLY.

Centre.		S.P. 20.	S.P. 72.	N. 17.	S.G. 29.	Least Significant Difference.
Aduku	..	0.5	6.5	7.5	13.5	6.2
	..	0.3	0.8	4.0	10.3	2.3
Kaberaido	..	3.0	1.5	20.0	31.0	13.0
	..	2.0	1.0	18.0	38.0	11.3
Ngetta	..	5.0	6.0	36.0	65.5	8.7
	..	5.0	5.5	15.0	41.0	20.9
Nyero	..	9.5	11.3	8.5	15.8	—
	..	5.0	3.5	9.5	13.0	—
Serere	..	1.0	1.8	4.3	12.3	2.7
	..	1.0	1.0	5.0	11.5	5.4
Kachumbala	..	0.8	1.0	6.5	12.8	4.4
	..	0.0	1.0	1.5	3.3	—
ALL CENTRES		2.8	3.4	11.3	22.3	2.2

Conclusions (all centres):—

1. S.P. 20 = S.P. 72 < N. 17 < S.G. 29.
2. Interaction of Variety × Centre is highly significant.

MEAN NUMBER OF INFECTED MEMBERS PER PLANT (i.e., Branches and/or Stems).

Centre.	S.P. 20.	S.P. 72.	N. 17.	S.G. 29.	Least Significant Difference.
Aduku	0.06	0.23	0.29	0.49	0.20
Kaberaido	0.02	0.02	0.08	0.24	0.10
Ngetta	0.06	0.08	0.69	0.83	0.25
Nyero	0.68	0.96	3.21	5.78	0.63
Serere	1.20	1.21	4.69	5.81	0.54
Kachumbala	0.19	0.26	1.18	3.78	1.14
Kibale	0.27	0.33	0.47	0.88	0.24
Mulanda	0.19	0.17	1.30	1.91	0.69
Vukula	0.03	0.04	0.09	0.23	0.07
Bugaya	0.02	0.02	0.08	0.17	0.07
Bulopa	0.02	0.03	0.15	0.33	0.10
Iganga	0.01	0.03	0.03	0.09	0.05
ALL CENTRES ..	0.228	0.279	1.021	1.710	0.111

Conclusions (all centres):—

1. S.P. 20 = S.P. 72 $\ll$ N. 17 $\ll$ S.G. 29.
2. Interaction of Variety $\times$ Centre highly significant.
3. These figures, although not taking into account the size of the individual lesions, probably give a truer picture of the intensity of the disease than percentage of plants attacked.

Final Conclusions:—

1. The varieties S.P. 20 and S.P. 72 undoubtedly show less infection of Blackarm disease than the varieties N. 17 and S.G. 29.
2. S.P. 20 shows fewer lesions on the branches than S.P. 72 but both have a similar degree of stem infection.
3. The old standard variety N. 17 shows much less Blackarm infection than S.G. 29.
4. The Teso, Bugwere and Budama Trials have more infected members per plant than the Trials in Lango and Busoga.

Kumi Variety Trial.

Observations were made on only one of the three North Teso Variety Trials (*vide* Serere Zone of Botanical Section's Annual Report).

The results are summarised below:—

	S.G. 29.	S.P. 72.	S.P. 20.	Least Significant Difference.
Percentage plants with Blackarm lesions ..	90.8	55.6	58.0	12.4
Percentage plants with Main Stem infection ..	58.4	15.6	7.2	9.2
Number of infected branches and/or stems per plant ..	4.46	1.04	1.02	0.73

Conclusions:—

With all three criteria of infection S.P. 20 and S.P. 72 are equal, and both have far less infection than S.G. 29.

EXPERIMENTAL RESULTS—SERERE.**Combined Variety, Spacing and Sowing Date Trial.**

A full description of this experiment will be found under the same heading in the Serere Zone of the Botanical Section's Report.

The following tables summarise the results of Blackarm lesion counts made during the middle of November, 1935.

A. TOTAL LESIONS PER PLANT (Means).**VARIETIES (Irrespective of Spacing or Sowing Date).**

Varieties.	Mean Blackarm Lesions per Plant.	Least Significant Difference.
S.G. 29	6.14	0.25
S.P. 72	1.44	
S.P. 20	1.34	
S.P. 43	1.13	
S.P. 48	1.19	
S.P. 56	1.63	

SOWING DATES (Irrespective of Varieties or Spacing).

Sowing Dates.						Mean Blackarm Lesions per Plant.	Least Significant Difference.
May 1st	..	..	..	..	..	3.94	0.37
May 31st	..	..	..	..	..	2.85	
July 1st	..	..	..	..	..	1.46	
August 1st	..	..	..	..	..	0.32	

SPACINGS (Irrespective of Sowing Dates or Varieties).

Spacings.						Mean Blackarm Lesions per Plant.	Least Significant Difference.
3' × ½'	..	..	..	..	..	2.14	no difference.
3' × 1'	..	..	..	..	..	2.22	
3' × 1½'	..	..	..	..	..	2.07	

INTERACTION OF SOWING DATE × SPACING (Mean Blackarm lesions per plant).

						3' × ½'	3' × 1'	3' × 1½'	Least Significant Difference.
May 1st	..	..	..	..	..	3.57	4.19	4.07	0.31
May 31st	..	..	..	..	..	2.95	2.89	2.71	
July 1st	..	..	..	..	..	1.67	1.51	1.20	
August 1st	..	..	..	..	..	0.38	0.29	0.29	

INTERACTION OF VARIETY × SOWING DATE (Mean Blackarm lesions per plant).

			May 1st.	May 31st.	July 1st.	August 1st.	Least Significant Difference.
S.G. 29	..	..	10.67	8.48	4.23	1.20	0.35
S.P. 72	..	..	2.72	1.71	1.14	0.19	
S.P. 20	..	..	2.69	1.78	0.74	0.14	
S.P. 43	..	..	2.12	1.46	0.83	0.13	
S.P. 48	..	..	2.27	1.56	0.81	0.12	
S.P. 56	..	..	3.20	2.13	1.01	0.17	

Conclusions:

Varieties (Irrespective of Spacings or Sowing Dates):—

- (a) S.G. 29 has a significantly higher number of Blackarm lesions than the other varieties.
 (b) S.P. 72 = S.P. 20 = S.P. 43 = S.P. 48.
 (c) S.P. 56 > S.P. 20, S.P. 43 and S.P. 48.
 (d) S.P. 56 = S.P. 72.

Sowing Dates (Irrespective of Variety or Spacing):—

May 1st > May 31st > July 1st > August 1st.

Spacings (Irrespective of Variety or Sowing Date):—

No difference between the three spacings.

Interaction of Sowing Date × Spacing:—

- (a) May 1st: $3' \times \frac{1}{2}' < 3' \times 1' = 3' \times 1\frac{1}{2}'$.
 (b) May 31st: All spacings equal.
 (c) July 1st: $3' \times \frac{1}{2}' = 3' \times 1' > 3' \times 1\frac{1}{2}'$.
 (d) August 1st: All spacings equal.

Interaction of Variety × Sowing Date:—

- (a) May 1st: S.G. 29 > S.P. 56 > S.P. 72 = S.P. 20 > S.P. 43 = S.P. 48.
 (b) May 31st: S.G. 29 > S.P. 56 > S.P. 72 = S.P. 20 = S.P. 43 = S.P. 48.
 (c) July 1st and August 1st:
 S.G. 29 > S.P. 56 = S.P. 72 = S.P. 20 = S.P. 43 = S.P. 48.

From the latter result one concludes that S.G. 29 develops Blackarm not only more seriously but also earlier than the other varieties.

B. STEM LESIONS PER PLANT.

VARIETIES (Irrespective of Spacing or Sowing Dates).

Varieties.						Mean Main-stem Lesions per Plant.	Least Significant Difference.
S.G. 29	..	..	..	..	..	0.39	0.02
S.P. 72	..	..	..	..	..	0.03	
S.P. 20	..	..	..	..	..	0.02	
S.P. 43	..	..	..	..	..	0.01	
S.P. 48	..	..	..	..	..	0.01	
S.P. 56	..	..	..	..	..	0.03	

The figure of 0.39 main stem lesions per plant for S.G. 29 means in effect that 39% of the plants of this variety have one or more Blackarm lesions on the main stem. The other varieties vary between 1% and 3%.

SPACINGS (Irrespective of Variety or Sowing Date).

Spacings.						Mean Main-stem Lesions per Plant.	Least Significant Difference.
3' × ½'	..	..	..	..	..	0.094	0.016
3' × 1'	..	..	..	..	..	0.082	
3' × 1½'	..	..	..	..	..	0.070	

Conclusions:

Varieties (Irrespective of Spacings or Sowing Dates):—

- (a) S.G. 29 >> all other varieties.
- (b) S.P. 72 = S.P. 56 > S.P. 43 = S.P. 48.
- (c) S.P. 72 = S.P. 56 = S.P. 20.
- (d) S.P. 20 = S.P. 43 = S.P. 48.

Spacings (Irrespective of Varieties or Sowing Dates):—

- (a) 3' × ½' >> 3' × 1½'.
- (b) 3' × ½' = 3' × 1'.
- (c) 3' × 1' = 3' × 1½'.

From the analysis of variance no other significances were obtained. This is of interest if one compares the effect of sowing dates on the mean Blackarm lesions per plant in Section A. above. It would seem that stem lesions are formed relatively early in the plant's life, and, therefore, one finds no difference between the stem lesions of the different sowing dates when the counts are made three-and-a-half months after the latest planting date. This figure—stem lesions per plant—probably gives a truer picture of the relative susceptibility of the strains than the total Blackarm lesions per plant. Here, again, no account was taken of relative sizes of the lesions.

C. BLACKARM INTENSITY.

It was found that large plants carried a higher number of lesions than small plants. There was considerable variation in size of plant as between varieties, spacings, and sowing dates, so a figure of plant size was obtained by weighing the whole of the aerial portions of all the plants in each plot at the end of the season.

This gross weight of vegetable matter was then divided by the number of plants in each plot. Thus a mean weight of vegetable matter per plant per plot was obtained. The mean weight of vegetable matter per plant was then divided into the total number of Blackarm lesions per plant, thus giving a figure which represents the number of Blackarm lesions per pound of plant material. This figure was termed "I", as it gives a truer picture of the intensity of the disease since size of plant is allowed for. The results obtained by using this figure are shown below.

VARIETIES (Irrespective of Spacing or Sowing Dates).

Varieties.						Mean Intensity per Plot (No. of lesions per pound of vegetable material).	Least Significant Difference.
S.G. 29	..	..	..	..	..	17.00	1.02
S.P. 72	..	..	..	..	..	3.42	
S.P. 20	..	..	..	..	..	4.17	
S.P. 43	..	..	..	..	..	3.19	
S.P. 48	..	..	..	..	..	3.60	
S.P. 56	..	..	..	..	..	3.06	

SOWING DATES (Irrespective of Variety or Spacing).

Sowing Dates.						Mean Intensity per Plot.	Least Significant Difference.
May 1st	..	..	..	..	..	12.14	1.74
May 31st	..	..	..	..	..	6.60	
July 1st	..	..	..	..	..	3.42	
August 1st	..	..	..	..	..	0.81	

SPACINGS (Irrespective of Varieties or Sowing Dates).

Spacings.						Mean Intensity per Plot.	Least Significant Difference.
3' × ½'	..	..	..	..	..	8.05	1.08
3' × 1'	..	..	..	..	..	5.25	
3' × 1½'	..	..	..	..	..	3.92	

INTERACTION OF SOWING DATE × SPACING.

						3' × ½'.	3' × 1'.	3' × 1½'.	Least Significant Difference.
May 1st	..	..	..	..	..	14.33	11.96	10.13	1.54
May 31st	..	..	..	..	..	10.63	5.54	3.63	
July 1st	..	..	..	..	..	5.71	2.92	1.63	
August 1st	..	..	..	..	..	1.54	0.58	0.29	

INTERACTION OF VARIETY × SOWING DATE.

						May 1st.	May 31st.	July 1st.	August 1st.	Least Significant Difference.
S.G. 29	..	..	..	..	..	34.42	20.17	9.83	3.58	2.00
S.P. 72	..	..	..	..	..	7.00	3.67	2.50	0.50	
S.P. 20	..	..	..	..	..	10.17	4.67	1.75	0.08	
S.P. 43	..	..	..	..	..	6.42	3.67	2.50	0.17	
S.P. 48	..	..	..	..	..	8.08	4.00	2.08	0.25	
S.P. 56	..	..	..	..	..	6.75	3.42	1.83	0.25	

INTERACTION OF VARIETY × SPACING.

						3' × ½'.	3' × 1'.	3' × 1½'.	Least Significant Difference.
S.G. 29	..	..	..	..	..	23.44	15.44	12.13	1.75
S.P. 72	..	..	..	..	..	4.94	2.75	2.56	
S.P. 20	..	..	..	..	..	5.06	4.00	3.44	
S.P. 43	..	..	..	..	..	4.94	2.69	1.94	
S.P. 48	..	..	..	..	..	5.13	3.81	1.88	
S.P. 56	..	..	..	..	..	4.81	2.81	1.56	

Conclusions:

Varieties (Irrespective of Spacing or Sowing Dates):—

- (a) S.G. 29 >> all other varieties.
 (b) S.P. 20 > S.P. 56.
 (c) S.P. 72 = S.P. 20 = S.P. 43 = S.P. 48.
 (d) S.P. 72 = S.P. 43 = S.P. 48 = S.P. 56.

Sowing Dates (Irrespective of Variety or Spacing):—

May 1st >>> May 31st >>> July 1st >>> August 1st.

Spacings (Irrespective of Variety or Sowing Dates):—

3' × ½' >>> 3' × 1' >> 3' × 1½'.

Interaction of Sowing Dates × Spacings:—

- (a) May 1st: 3' × ½' >>> 3' × 1' >> 3' × 1½'.
 (b) May 31st: 3' × ½' >>> 3' × 1' >> 3' × 1½'.
 (c) July 1st: 3' × ½' >>> 3' × 1' = 3' × 1½'.
 (d) August 1st: 3' × ½' = 3' × 1' = 3' × 1½'.

- July 1st = August 1st.
 July 1st.
 August 1st.
 July 1st = August 1st.

July 1st = August 1st.

- $$\begin{array}{r} \times 1\frac{1}{2}' \\ \times 1\frac{1}{2}' \\ \times 1\frac{1}{2}' \end{array}$$

usions:

ng
as

gs

11

ne
is
ns

of

h t.

ANNUAL REPORT OF THE AGRICULTURAL CHEMIST.

STAFF MOVEMENTS.

The Agricultural Chemist left Kampala on home leave on May 9th and returned on December 17th. Whilst on leave he attended the Third International Congress of Soil Science at Oxford as the official delegate from Uganda.

The Assistant Chemist visited Nairobi, from July 22nd to July 30th. At Nairobi he attended the meetings and demonstrations arranged in connection with the Kenya Coffee Days. A paper was presented, in collaboration with Mr. A. S. Thomas, describing the results, obtained to date, of the experiment in progress at the Kampala Plantation on the effect of different ground treatments on the soil conditions governing the growth of coffee.

The Assistant Chemist also attended the meetings in Kampala of the Uganda Planters' Association and read a short paper on "Some aspects of soil erosion."

During the absence of the Government Analyst on long leave certain analytical work was done for the Medical and Police Departments.

SUMMARY OF LABORATORY WORK.

The following is a summary of work carried out in the Laboratory during the year:—

SOILS.							
Reaction	...	...	...	...	...	...	90
Moisture at sticky point	...	...	...	...	...	...	94
Loss on ignition	...	...	...	...	...	...	94
Organic carbon	...	...	...	...	...	...	177
Nitrogen	...	...	...	...	...	...	140
Available nutrients (phosphate, potash, and calcium)	...	...	...	...	...	...	110
Nitrates	...	...	...	...	...	Approximately	500
Moistures	...	...	...	...	...	Approximately	500
OTHER WORK.							
Composts	...	...	...	...	...	...	5
Essential oil extractions	...	...	...	...	...	...	11
Fibre extractions	...	...	...	...	...	...	4
Cassava, complete analysis	...	...	...	...	...	...	16
Alcohol determination	...	...	...	...	...	...	3
Boiler water and boiler scale, complete analysis	...	...	...	...	...	...	1
Arsenic compounds	...	...	...	...	...	...	3
Flours	...	...	...	...	...	...	2
Human organs, tests for metallic poisons	...	...	...	...	...	...	6
Sim-sim, examination for admixture	...	...	...	...	...	...	6

SOILS AND FERTILIZERS.

A. EROSION AND REGENERATION.

In all questions of soil deterioration or loss of fertility there are two closely related factors to consider. On sloping land with cotton as the main crop the major factor is erosion and on the flats the main loss is by leaching and the carrying off of crops without putting anything back. Of course, the second factor also operates on sloping land.

Following on the results of the erosion experiment discussed in last year's report an attempt has been made in collaboration with the Senior Agricultural Officer to make the experimental work more comprehensive. A plan of experiment was drawn up and sent to the Agricultural Adviser to the Secretary of State and through him to the Statistical Department

at Rothamsted for criticism and lay-out. The plans have been approved and work will be started in 1936. The first experiment is to be laid down on a steady slope and the following anti-erosion treatments will be applied on ploughed and on hand-cultivated plots:—

- (a) Lemon grass contour hedges.
- (b) Contour strips of sweet potatoes.
- (c) Contour strips of uncultivated land.
- (d) Natural terracing by piling up cleared trash.
- (e) Control—no treatment.

The site of this experiment has been surveyed and soil samples taken.

The second factor is to be tackled on almost flat land and the experiment is designed to find out the minimum resting period necessary under various types of cover to maintain fertility with and without farmyard manure. There are fifteen rotations embodying 1, 2 and 3 years of each of the following covers:—

- (1) Natural weeds and grass.
- (2) Planted grass.
- (3) Planted grass lopped to simulate grazing.
- (4) Green manure lopped to simulate grazing.
- (5) Green manure dug in.

The plots of each of the above treatments are to be sub-divided at random for applications of farmyard manure at rates of 0, 2½ and 5 tons per acre. A full account of these experiments is being prepared for the *East African Agricultural Journal*.

Meanwhile a committee consisting of the Senior Agricultural Officer, Senior Veterinary Officer, Divisional Forestry Officer, under the Chairmanship of an Administrative Officer was appointed to consider any special measures necessary to deal with the erosion and deterioration of the light soils of Teso District. As a result, a team consisting of one officer of each of these Departments is to be set aside to deal with the question. The Agricultural Chemist is to be the technical and experimental adviser stationed at Serere. The experiments already outlined should give in time the answers to the questions of time and type of resting period and control of erosion but the other allied questions of afforestation, water supplies, health questions, cattle population and possibly the re-distribution of population are being considered by a Committee consisting of all the Heads of Departments or services concerned.

B. FARMYARD MANURE.

Intimately linked with the questions of erosion and regeneration already discussed is that of the storage and use of farmyard manure. At the moment the cattle are grazed on waste land and seasonal swamps in the day-time and shut up in open air kraals at night with no bedding. The valuable droppings of the animals are thus lost to the land. For several years with the co-operation of Officers of the Agricultural Education Section tests of manures prepared in different ways have been made. The first test was made on the Bukalasa small holdings, where the cattle were bedded down daily with elephant grass and wastes. The houses were cleared out at intervals and the manure stored as indicated in Table I. It is clear that under our conditions the manure is best stored in a stack with roof, the effects of leaching and denitrification being apparent in the other treatments. Unfortunately this method does offer more scope for fly breeding and flies seriously affect the condition of the animals. Latterly trials have been made of bedding the animals in darkened kraals and leaving the manure under the animals until required in the field. As this method will entail a minimum of labour and reduces fly breeding to a minimum it is hoped that it will appeal to the peasant farmer.

TABLE I.—BUKALASA KRAAL MANURE.

Type.	Moisture % Total.	Loss on Ignition.	C/N (Estimated)	% N.	% soluble in 1:1 HCl.	
					P ₂ O ₅	K ₂ O
All calculated on oven dry weight.						
Rotted in pit with roof ..	40.8	20.5	11.3	1.05	0.079	0.030
Rotted in pit without roof ..	37.3	22.0	18.5	0.69	0.079	0.049
Rotted in stack without roof ..	47.7	27.6	12.9	1.24	0.170	1.380
Rotted in stack with roof ..	39.3	51.3	13.9	2.15	0.445	—*
Rotted in pit with soil covering ..	60.4	40.6	18.3	1.29	0.328	—*

* Not determined; but greater than the other three.

C. COMPOSTS.

During the years 1925—29 many attempts were made to prepare a useful artificial farmyard manure in those areas where fly and disease made the keeping of cattle impossible. Manures involving the use of Adco undoubtedly did give increases in the yield of coffee on one estate but the increases were small compared with those obtained when either mulch or cotton seed were applied. Such methods were also far beyond the range of the ordinary peasant farmer and the work was abandoned until the publication of the work of Howard and Wad¹ and later of Jackson² from Indore gave an impetus to the idea of compost manufacture. Work was started at Serere and Bukalasa. At Serere one ton per day is being turned out at a cost of about four shillings per ton.

The compost is being used on the experiment farm and does help to keep the land in good heart but on analysis it compares very unfavourably with figures issued from Indore.

Up to the present no special leguminous crops have been grown for mixing with the normal bedding of the cattle and the figures given refer mainly to *Imperata cylindrica* for Serere and *Penisetum purpureum* at Bukalasa. A crop of sunn hemp is now being grown to mix with the other farm wastes in an attempt to bring the final compost up to standard.

TABLE II.—COMPOSTS.

Place of Origin.				% Moisture on Total.	Loss on Ignition.	% Carbon Calculated.	% N.	C/N. Ratio.
All calculated on oven dry weight.								
Serere Station:								
"Wet method"	..	..	..	9.1	10.3	5.97	0.43	13.9
"Dry method"	..	..	..	1.8	13.7	7.93	0.46	17.2
Serere Small Holdings:								
Holding 1	..	..	..	33.2	14.2	7.50*	0.51	14.7
Holding 6	..	..	..	23.3	8.6	4.28*	0.35	12.2
Mbarara	..	..	..	38.0	16.2	9.40	0.78	12.1
Bukalasa	..	..	..	57.0	23.5	13.64	0.77	17.7
Compost described from Lyamungu Station				..	27.0	18.4	10.70	0.90
Indore mean of 12 heaps				..	—	—	—	.896
								12.85

* Estimated by wet combustion and corrected.

D. COTTON SEED.

Very few people realise the tremendous drain on the natural resources of a country the cotton crop can be under present conditions. Taking an average crop of 250,000 bales of lint, it represents about 90,000 tons of cotton seed. Of this about 11,000 tons would be ear-marked for seed, about 1,000 tons for manure on European estates and the remaining 78,000 tons burnt either as ginnery fuel or in heaps in the compound of the ginnery or exported. This represents about 2,700 tons nitrogen, 1,000 tons P_2O_5 and 860 tons potash. All this represents an irreplaceable loss to the country as almost all the cotton is produced by the native peasant grower who will never be able to afford to buy the artificial fertilisers necessary to make good this loss.

It is difficult to make any practical suggestions which would prevent this appalling waste and at the same time compensate those concerned for the loss of immediate revenue. During the year Dr. Griffith suggested that it might be profitable to investigate the possibility of using cotton seed oil as a fuel for internal combustion (diesel) engines and for direct firing of boilers.

Opportunity was given for practical expression of these views by the appointment of the Advisory Committee for the Development of Native Agricultural Production of a sub-committee, on which the section was represented, with instructions to explore the possibilities of utilising cotton seed for manurial purposes in native agriculture with special reference to the questions of control of cotton diseases, rendering the seed non-viable and the control of plague.

In previous reports it has been shown that cotton seed is an excellent fertiliser for coffee on non-native estates and that the oil merely delays the action and is eventually decomposed by bacteria.

1. *The Waste Products of Agriculture.* Howard and Wad, Oxford University Press, 1931.

2. *The Supply of Humus to Soils.* Jackson, Wad and Panse, *Empire Cotton Growing Review*, 1934. XI, p. 111.

Further work on this was carried out in which the soil round some coffee trees was actually treated with 3 pints of oil per tree (3 tons per acre of seed) without ill effect. Cotton seed could not, however, be issued to native growers for manurial purposes unless it had previously been made non-viable particularly in areas where a new strain was due to be issued for planting. It is difficult, too, to visualise composting at ginneries and the issue of compost. All the questions set the sub-committee would automatically be solved by the process of crushing to extract the oil. To be popular and to serve its purpose the cake or meal must be given free or at very small charge to the grower to be fed to his stock or to be used directly as manure. The oil would have to bear the initial cost of the seed and that of the crushing. The sub-committee decided that the first step indicated by their terms of reference was to find economic uses for the oil. Accordingly about 30 gallons of cotton seed oil was kindly tried out on a stationary diesel engine by Mr. McLeod Young, Chief Engineer at the Uganda Sugar Factory (Mr. Nanji Kalidas Mehta, M.B.E.). Mr. Young, considered the results of his tests distinctly promising although he was unable to do extensive tests with the amount of oil at his disposal.

The sub-committee therefore proposes to forward Mr. Young's report with the recommendation that the Fuel Research Institute should be asked to carry out trials of the oil as a direct firing fuel in addition to trials as a diesel fuel. Other uses for the oil suggested are: export as oil, soap making, anti-malaria work and disinfectant.

E. TEA SOILS.

A number of soil samples were submitted during the year to be tested for reaction in order to determine their suitability for tea growing. In addition, a number of estates was visited with the same object. In all cases a non-committal opinion was given. Whilst it appears that, in tea areas in other parts of the world, tea is known to prefer soils with a pH of 5 to 5.5 it is by no means certain that this applies without reservation in Uganda. Tea is well established and so far of good appearance and yielding well on soils much less acid than this. An opportunity will occur to investigate this on Kyambogo, an estate opened by the Department for experimental work on tea. A preliminary survey of the estate has revealed the fact that although most of the soil is on the acid side there is a small area in which there is a calcareous layer at about 3 ft. from the surface.

F. COTTON SOILS.

Helopeltis.—The only severe *Helopeltis* reported during the year was from the Busoga District. The Agricultural Officer sent in soil samples from neighbouring affected and unaffected or lightly-affected areas and analysis of these in the laboratory has yielded results of interest. These results are given in Table IV. The soils from the unaffected parts show marked superiority over those from the affected parts in all constituents. Andrews¹ working on the Tea Mosquito Bug (*Helopeltis theivora*) which is very closely allied to *H. bergrothii* the pest of cotton (and tea) in Uganda, and of tea in Nyasaland, found a correlation between severity of attack by this insect and the phosphate and potash content of the soil. He mentions manuring with potash manures as having a transient beneficial effect.

It is hardly justifiable to draw any conclusions from the figures given in the table but nevertheless they would seem to support Andrews' view that soil conditions are a determining factor. It should, however, be pointed out that deficiency in potash and phosphate in the present instance is accompanied by general soil poverty and it seems not unlikely that the latter may be the more important point. It is hoped to gain more information on these aspects in the near future when the work on the relative effects of soil and climate on the intensity of insect attack has been carried a stage further.

TABLE IV.—DATA ON SOILS FROM NEIGHBOURING PLOTS OF COTTON RESPECTIVELY BADLY AFFECTED AND UNAFFECTED OR SLIGHTLY AFFECTED BY HELOPELTIS.

		Sample Depth.	% Organic Matter.	% Available Nutrients.		
				P ₂ O ₅	K ₂ O	CaO
Plot I.	Not Affected ..	0—12"	3.46	0.0018	0.083	0.634
		12"—24"	2.50	0.0014	0.061	0.527
	Badly Affected ..	0—12"	2.58	<0.001	0.017	0.200
		12"—24"	2.19	<0.001	0.013	0.102
Plot II.	Not Affected ..	0—12"	3.43	0.0024	0.062	0.346
		12"—24"	2.38	<0.001	0.074	0.212
	Badly Affected ..	0—12"	2.45	0.0022	0.019	0.186
		12"—24"	1.65	0.0019	0.0019	0.070

1. Factors affecting the control of the Tea Mosquito Bug, *Bul. Indian Tea Association*, E. A. Andrews, 1925.

G. COFFEE SOILS.

BUGUSEGE CULTURAL EXPERIMENT.

This experiment, planted in 1932, consists of the following treatments in the form of randomised blocks: Weed cover, clean weeded, permanent cover crop, cover crop from October to March only, banana leaf mulch, banana leaf and stem mulch, and *Leucaena glauca* cover. Considerable differences now exist between the plots as may be seen by reference to Table V.

TABLE V.—DATA ON SOILS OF THE BUGUSEGE CULTURAL EXPERIMENT, BLOCK B.

Treatment.	Depth.	Moisture at Point of Stickiness.	Loss on Ignition.	Organic Carbon.	Organic Nitrogen.	C/N.	Easily Soluble Nutrients.		
							P ₂ O ₅	K ₂ O	CaO
Weed cover	0 — 8"	54.2	17.5	2.95	0.379	7.8	0.0095	0.111	0.883
	6"—18"	54.6	14.8	1.07	0.237	4.5	0.0022	0.066	0.504
Clean weeded	0 — 6"	55.2	15.4	1.90	0.281	6.8	0.0026	0.071	0.600
	6"—18"	59.4	14.2	0.80	0.188	4.3	0.0010	0.042	0.422
Two cover crops ..	0 — 6"	57.4	17.0	2.83	0.251	11.3	0.0094	0.112	0.861
	6"—18"	53.8	14.6	0.95	0.128	7.4	0.0011	0.066	0.373
Banana leaf mulch ..	0 — 6"	54.6	17.6	2.83	0.351	8.1	0.0103	0.121	0.761
	6"—18"	56.6	14.6	1.11	0.208	5.3	0.0029	0.049	0.467
October—March cover ..	0 — 6"	55.4	17.0	1.96	—	—	0.0026	0.097	0.630
	6"—18"	57.6	14.4	0.88	0.189	4.7	0.0011	0.061	0.357
Banana leaf and stems mulch	0 — 6"	55.9	17.3	2.75	0.293	9.4	0.0099	0.211	0.832
	6"—18"	57.5	13.8	0.84	0.181	4.6	0.082	0.082	0.391
<i>Leucaena glauca</i> ..	0 — 6"	54.4	16.8	2.27	0.321	7.1	0.0047	0.089	0.752
	6"—18"	56.5	14.1	0.86	0.190	4.5	0.0008	0.079	0.399

The most striking feature of these data is the substantial drop in organic matter on the clean weeding and October to March cover treatments. Here again we have evidence of the combined effects of erosion and abnormal combustion of organic matter when the soil lacks cover or shade. The site of this experiment is a fairly level one for the district but still the amount of organic matter burnt out or lost by erosion in the three-year period is sufficient to change completely the soil conditions and the natural economy of the crop. In addition, this loss of organic matter is accompanied as usual by a significant loss of easily soluble nutrients. It is quite clear that the loss of the fine fractions is the most serious thing that can occur in tropical soils and the figures offer a complete explanation of the extremely poor condition of coffee in Bugishu before mulching was generally adopted. The close linkage of organic matter and easily soluble nutrients is again shown and the field phosphate test may be used on known soil types to demonstrate the degree of erosion as stated in last year's report.

Another interesting point about these Bugusege figures is the large increase in potash on the plots mulched with banana leaf and stems. The increase actually corresponds to a dressing of about two tons the acre of a potash fertiliser, and this on a soil which was already well endowed with potash.

The following table gives the yield figures for 1934 and 1935 on the experiment:—

TABLE VI.

Treatment.	Yield in Lbs. Cherry per Treatment.		
	1934.	1935.	Total.
Weed cover	—	143	143
Clean weeded	104	752	856
Two cover crops	—	341	341
Banana leaf mulch	538	844	1,382
October—March cover	—	904	904
Banana leaf and stems mulch	631	1,074	1,705
<i>Leucaena glauca</i>	115	548	663

Cover Crops.—During the early part of the year a circular letter was sent to all European Planters asking for their co-operation in the matter of making observations on various cover crops for coffee, the seed to be supplied by the Department. This step was taken at the suggestion of the Coffee Experiment Sub-committee of the Coffee Board. The response to the circular was very disappointing, only two planters replying and asking for seed.

Ground Treatment Experiment.—This experiment, described in the Assistant Botanist's Annual Report for 1934 as well as in the Chemist's, was continued during the year.

H. SOILS (GENERAL).

In addition to investigations of a specialised nature such as those described above a considerable amount of work was done on soil survey of a general nature, both in the field and the laboratory. In the field work a field testing outfit, designed during the year, proved of great value. The set consists of nineteen reagents each giving a specific test for some soil constituent. The reagents and tests are described fully by Spurway¹, and a description of the set has been submitted to the *East African Journal of Agriculture* for publication.

In July the Journal of the Society of Chemical Industry published a communication from this section entitled "A Note on the determination of carbon in soils by the wet combustion method." This note described certain modifications of the wet combustion method as described by Hardy² which in the authors' opinion make that method a more useful and reliable tool in routine soil work. The modified method is now used in this laboratory for all determinations of soil organic matter and by means of it three determinations are done per day in duplicate by an African assistant.

Owing to the large amount of travelling which was done and to the fact that the section has been short staffed throughout the year less has been done than usual in the way of survey laboratory work. A large number of spot samples have accumulated, however, and work on these is being continued as other more urgent enquiries permit.

GENERAL WORK.

A. FIBRES.

Sunn Hemp.—Work on this crop was discontinued as, in spite of the favourable report received on a sample sent to the Imperial Institute in 1934, it was discovered on reference to costings obtained on Serere Plantation that the cost of cultivation, handling, and shipping was prohibitive.

Ramie.—There has been no further development since 1934 with regard to this crop but the plots are being kept up in various districts and observations on growth, etc., have been continued.

Abroma Augusta.—The introduction of this plant was reported in the Assistant Botanist's (Kampala) Annual Report for 1934. In June, 1935, by which time growth was from 8 to 10 feet, few plants were cut for trial retting. For this purpose the bark was stripped off the stems. A portion was retted chemically by the method referred to in connection with ramie in our 1934 report. The remainder was water-retted for varying periods. Samples of fibre of excellent appearance were obtained and these were sent to the Imperial Institute for valuation and report. The report appears verbatim in the appendix. It will be seen that it is promising and every effort is being made by the Assistant Botanist to comply with the request for a large bulk sample.

In view of the unfavourable report on the chemically retted product, and in view of the ease of the water retting, future samples will be water-retted and the work will be carried out by the Assistant Botanist, Kampala, to whose reports reference should be made for further information.

B. CASSAVA.

It has been repeatedly suggested that the food value of cassava may be affected by infection with Mosaic disease. This point was investigated with the assistance of the Agricultural Officer, Teso. Samples of the dried roots of the following varieties of cassava were sent in by him: Bobby Hanson, Bunch of Keys, Brown Stick, Mugowa, Nodewide, Nyumbezunga, Numbu, Smalling, and Teso. Of the first seven, samples of roots from both healthy and diseased plants were obtainable, the sample of the variety Smalling was all from healthy plants. The following table gives the results of the analyses made. It will be seen that there is no indication of effect of the disease on the food constituents determined.

1. C. H. Spurway. Soil Testing, Technical Bulletin No. 132 of the Agricultural Experiment Station, Michigan State College.
2. Hardy, F., A note on the determination of soil organic matter. *J. Agric. Sci.* 1929, 19, p. 727.

TABLE VII.—ANALYSIS OF HEALTHY AND OF MOSAIC INFECTED SAMPLES OF CASSAVA.

Variety.	Moisture.		Ash.		Protein.		Crude Fibre.		Carbohydrate and Fat (by difference).	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
Bobby Hanson ..	13.4	12.8	1.58	1.56	1.70	1.86	2.12	2.31	81.2	81.5
Bunch of keys ..	13.9	13.7	1.71	1.94	2.09	1.67	2.27	2.42	79.9	79.9
Brown Stick ..	12.3	12.7	1.23	1.27	1.80	1.72	2.48	2.13	82.2	82.2
Mugowa ..	12.7	13.2	1.48	1.57	1.86	1.78	1.90	2.07	82.1	81.6
Node wide ..	12.8	12.7	1.67	1.74	1.68	1.64	2.25	2.82	81.6	81.1
Nyumbezunga ..	13.3	13.5	1.55	1.55	1.83	1.55	2.25	2.36	81.1	81.0
Numbu ..	13.1	13.1	1.49	1.21	1.81	1.81	2.23	2.15	81.4	81.7
Smalling ..	11.8	—	1.32	—	1.14	—	1.79	—	84.0	—
Teso ..	—	12.2	—	2.00	—	1.70	—	2.46	—	81.6

C. SIM-SIM ADMIXTURE.

In continuation of the work reported in the Annual Report of this section for 1933 the Agricultural Officer, Teso, submitted seven samples of sim-sim seed for examination. The samples were noticeably worse than those examined in 1933, as the following table shows.

TABLE VIII.

Place of Origin of Sample.	Admixture. %	Nature of Admixture.
Dakabella No. 1 ..	5.8	Cotton, soil, rat excreta, caterpillars, immature seed.
Dakabella No. 2 ..	8.6	Caterpillars, webbing, twigs, soil, immature seed.
Dakabella No. 3 ..	3.4	Caterpillars, webbing, twigs, soil, immature seed.
Dakabella No. 8 ..	2.7	Soil and immature seed.
Dakabella No. 15 ..	4.6	Soil and immature seed.
Tira ..	3.1	Twigs, soil, immature seed.
Serere ..	3.4	Soil and immature seed.

D. ESSENTIAL OILS.

Distillations of a number of oils were carried out in the course of the year. Samples of each oil were sent to the Imperial Institute for valuation and report and the reports obtained are reproduced verbatim in the appendices. Work on essential oils can now be said to have passed out of the experimental distillation stage and as there continues to be practically no interest taken in this type of product future work will be confined to growth observations on a few of the more promising oil plants. This work will be carried on by the Assistant Botanist (Kampala) in whose Annual Report for this year will be found comments on the Imperial Institute reports.

E. MISCELLANEOUS ANALYSES.

A sample of maize flour was examined for admixture. Microscopic examination showed the sample to have been adulterated with millet.

A sample of orange wine and a sample of banana spirit were analysed for alcohol content.

Various human organs were examined for the Medical Department and one powder for the Police. The latter was being sold locally as a rat poison and proved on analysis to be practically pure sodium arsenate.

W. S. MARTIN,
Agricultural Chemist.

G. ap. GRIFFITH,
Assistant Agricultural Chemist.

REPORT OF BOTANICAL SECTION FOR THE YEAR ENDING JUNE 30TH, 1936.

INTRODUCTION.

STAFF.

Mr. Nye, Senior Botanist, was on leave from the end of June, 1935, until February, 1936, during which time Mr. Hosking (Assistant Botanist) acted as Senior Botanist; remaining stationed at Serere, while Mr. Jameson (Agricultural Officer) acted as Assistant Botanist stationed at Bukalasa.

Mr. Davidson (Agricultural Officer) carried on the Botanical work at Serere for three months during Mr. Hosking's absence on sick leave.

Mr. Thomas, Assistant Botanist, was stationed at Kampala throughout the period and in addition to his normal duties was in charge of the Kampala Plantation.

Mr. Chandler (Plantation Manager) was stationed in Kampala to assist the Assistant Botanist. He was also in charge of the Botanical Gardens, Entebbe.

COTTON.

The weather conditions were generally abnormal but more so in the Western Area than in the East. Serere produced very high yields especially on the Bulk increase plots which gave an average yield of 863 lbs. per acre over 40 acres, with the U. 4/4/2 derivative S.P. 20.

The U. 4/4/2 derivative S.P. 87 yielded well and is to be increased as rapidly as possible.

Further evidence was forthcoming of the yield superiority of the U. 4/4/2 derivatives in the Eastern Province, but as yet the quality of these is not up to our minimum requirements. As a considerable increase in yield would result from distribution of S.P. 20, very detailed reports are being obtained from all sources as to the demand and price to be expected for such a cotton. S.P. 87 is still superior to S.P. 20 in quality but it was not as good in this respect as in the previous season. A selection from S.P. 87—S.P. 92—is a promising production from this season's breeding plot.

The strain B.P. 50 which promised so well at Bukalasa last season has shown itself to be very susceptible to Wilt and must therefore be abandoned. Its spinning qualities were also disappointing especially after such excellent reports from local lint buyers.

The Wilt problem is of major importance in the Western Area and work on resistance to this disease is being carried out in close co-operation with the Mycologist.

S.G. 23/8 maintained its spinning superiority and it still appears to suffer less from Wilt than most other strains.

A promising U. 4 strain—U.B. 24/4—has been isolated in this year's breeding plot at Bukalasa.

S.G. 29 has shown signs of deterioration in the Eastern Province but in West Nile and Bunyoro its quality appears to be superior to Buganda Local; it was also classed as being the best of the Serere samples this season.

COFFEE.

Considerable progress with selection of Nganda coffee has been made and a good representative collection is now in being. Studies of Wild coffee have resulted in the discovery of several promising types. Selected trees are being used to provide seedlings for general distribution.

Self-pollination was again comparatively successful with *Robusta*.

A breeding plot has been started at the new Kawanda Plantation and an area of 5—6 acres was planted up.

With regard to vegetative reproduction the grafts have shown great uniformity and have made good progress. The *Robusta* grafts are in better health than the *Arabica* ones. Cuttings are still rather unsatisfactory but work on this method of propagation is continuing.

OTHER CROPS.

With regard to other crops there is nothing of outstanding importance to report. Work is proceeding on all economic and food crops with the object of obtaining improved strains.

So far, selection in groundnuts has not given any high yielding types while in the case of sim-sim a satisfactory method of ensuring self-fertilisation has yet to be found. Reports on essential oils have been more promising than hitherto.

G. W. NYE,
Senior Botanist.

PART I.—BOTANICAL WORK, KAMPALA.

STAFF.

The Plantation Manager and the Assistant Botanist were resident at Kampala throughout the year, with the exception of short periods on safari and on local leave. The Plantation Manager continued to supervise the Botanic Gardens, Entebbe: and in August, when the Agricultural Officer (Education) went on leave, the upkeep of the Kampala Plantation was transferred to the Botanical Division and Mr. Chandler took over the charge. A separate report on the Kampala Planation has not been written, for most of the more important results have been included in this report.

METEOROLOGY.

2. The total rainfall for the year at Kampala was above the average, but it was abnormally distributed and rendered planting difficult at times. January was dry; February was very wet—with a total rainfall of 7.18 inches, which is 4.39 inches above the average; March and April, which usually are good months for planting, were exceptionally dry—in April there was only 2.60 inches of rain, a figure 5.19 inches below the average. May and June were very wet; July, August and September were dry on the whole—the rainfall for August was above the average, but most of it fell on two consecutive days. The rainfall for October, November and December was well above the normal, making the total for the year 57.72 inches, a figure 8.31 inches above the average, and the highest recorded since 1926.

COFFEE.

A. SELECTION AND BREEDING.

3. *Selection.*—The work of selection of *Robusta* coffee, and more especially of the native ("Nganda") types, was continued throughout the year. Most of the trees in Kyagwe and Kyadondo, selected in 1933, were visited twice during the year—in April and May and again in October and November. In the report for 1934, it was mentioned that many trees showed a tendency to biennial cropping, for they were fruiting heavily in 1933 when they were selected, but cropped lightly in 1934: this observation was confirmed in 1935, when almost all the trees again bore heavy crops, although in one or two instances they had not recovered from the effects of overbearing in 1933 and therefore produced little fruit. A safari for the purpose of making further selections of coffee was made in the Masaka District at the end of June and the beginning of July. The work of selection in Buddu was much facilitated by the Agricultural Officer, who showed me the trees that had already been chosen as mother trees of the seedlings raised for distribution. Four spreading trees were labelled for breeding work, together with one outstanding tree of the erect type: one spreading tree (247=M1) was exceptional—it was procumbent in habit, spreading to a distance of twenty-six feet and in 1934 it had borne about one hundred pounds of coffee in parchment. In the Kiebbe gombolola, near the Tanganyika border, there are many old trees growing in the banana gardens: these trees appear to be of a rather different type from most of those in Uganda, being smaller in size than most trees of the same age in other districts: none of the four trees that were selected here were less than twenty years old, while one of them, whose reputation for heavy cropping was such that it had been named "Nalongo", *i.e.*, the mother of twins, probably was at least fifty years of age.

4. The Sese Islands also were visited again: as the coffee selections there were made in 1932, these trees have been under observation for four seasons: but, in contrast to the trees on the mainland, they have not exhibited a marked tendency of biennial cropping and almost always are bearing fruits of different ages—it may be that the high and well-distributed rainfall of the islands is the reason for this phenomenon. In the selection of "Nganda" coffee, an attempt has been made to include no trees less than ten years old, but this principle was relaxed with respect to a plot of some acres on Bukasa Island which has been planted with progeny of selection 204 by the owner of that tree: three more selections were made there, the youngest of them being four years old. Selection of *Robusta* coffee has been carried out by the natives of Uganda for some years and plots, which have been planted with the seed of one good tree, furnish valuable material for breeding work: there is another large plot in Buddu, all planted with the progeny of two excellent trees (M1 and M2), which in a few years

should afford great scope for selection. Two more selections were made on another farm on Bukasa Island where there are a number of trees planted eighty years ago, for this was one of the plots from which coffee was exported to the mainland in the nineteenth century. This farm also showed how tenacious of life *Robusta* coffee can be—one tree had been flattened by the fall of a large forest tree, but yet was growing well: while another, which branched near ground level, had a *Markhamia platycalyx* (Musambya) tree with a trunk fifteen inches in diameter growing in the centre of it.

5. *Breeding*.—The old “Nganda” coffee trees on native farms in Uganda provide excellent material on which to commence the work on coffee breeding—few other countries, if any, can show better original stock: all the more important coffee areas have been inspected and it is probable that a representative collection of the best trees now have been selected. These trees at present are used as a source of supply of the seed for the central nurseries, in which seedlings are raised for distribution to native growers; but it is obvious that the value of individuals as mother trees remains to be proved, except in the cases mentioned above, where natives have planted plots with the progeny of one tree. It is hoped to establish progeny rows of all the more desirable selections—some of the trees selected first will not be used for breeding work, for their subsequent behaviour has not justified their retention and better trees since have been found. It is also highly desirable that there should be on the plantations of the department a source from which a bulk of “Nganda” seed can be supplied, for the collection of seed from these scattered trees is attended by many difficulties and delays: the visits to the selections entail a considerable amount of travelling, especially for the collection of seed for breeding work—an operation which obviously should be supervised personally.

6. In 1934 seedlings of twelve “Nganda” (spreading) selected trees and *Robusta* (erect) selected trees were supplied to the Senior Agricultural Officer, Kampala, for planting progeny rows at the central nurseries at Mukono. The “Nganda” types, which were planted in May, 1934, made very good growth and commenced to flower before the end of 1935—an occurrence which should disprove the belief that the “Nganda” types are very slow in growth and in bearing: a more striking demonstration of the rapidity with which “Nganda” trees may grow was seen in Bwamba, where the progeny of “Nganda” selections, planted in March, 1935, had commenced to flower by November of the same year. The planting of progeny rows at Kawanda also was commenced in April. The land allocated for this crop was a strip two hundred yards wide along a slope: it was decided that the best method of lay-out for breeding work would be to divide it into two strips, nearly one hundred yards wide, by a path; and to plant the coffee in rows up and down the slopes—erosion to be controlled by lines of mulch or of cover crop (e.g., *Centrosema pubescens* or *Leucaena glauca*) along the slopes, at right angles to the rows of coffee. Progeny of seventeen spreading (“Nganda”) trees and of seven erect (*Robusta*) trees was planted out: the former were spaced at 15 feet × 15 feet and will be trained to spread: while the latter were spaced at 12 feet × 12 feet and will be trained on a modified Agobiada system: and in each case the permanent trees were interplanted with others of the same progeny, to be trained on the single stem system and to be removed after a few years. The space was sufficient for 40 permanent and 40 temporary trees of the spreading types, and 50 permanent and 50 temporary trees of the erect types: such numbers of progeny should be sufficient to furnish a good idea of the value of a selection as a mother tree. Unfortunately, the weather was dry after the planting had been finished, and a number of blanks resulted, which were filled at the end of May, and the beginning of June: by the end of August the drought had caused many more deaths and a lot of replanting was done in September, the seedlings being put out as stumps—that is, cut back severely two weeks before planting. A total area between five and six acres was planted at Kawanda with progeny rows of various selections, and seedlings sufficient to fill about the same area have been raised for planting during the current season—some from open pollinations of various selected trees and some from self pollinations of trees on the Government Plantation, Kampala, carried out in 1934.

7. The individual recording of the trees on Plot 4, Kampala Plantation, planted in progeny rows from Mr. Liebenberg’s selections in 1930, was continued. Owing to the tendency of *Robusta* coffee to biennial bearing, there have been great variations in the relative production of the individual trees from year to year—it is obvious that records over a series of years are necessary before definite selections can be made. The weight of a random sample of one hundred cherries, the number of berries therein and the weight of the dried beans also have been investigated for each tree: the results, as a whole, correspond fairly well with those obtained in 1933, the first time this work was done; but there are several instances in which the figures differ considerably, as might be expected from the fact that when the crop on any tree is large, the individual cherries often are smaller than when the crop is small.

8. *Self Pollination*.—In 1934 eight tentative selections were made on this plot, and in February, 1935, three or four primary branches on each of these selections were enclosed in mosquito netting sleeves before the flowers opened; and the flowers were self pollinated with a camel hair brush. Two older selected trees (S1 and S2) stand on this plot and some of their branches were treated in the same way. The results obtained were as follows:—

Tree No.	No. of Flowers Pollinated.	No. of Cherries Ripened.	Percentage Fertilisation.	No. of Beans Formed.	Ratio Beans/Cherries Self Pollination.	Ratio Beans/Cherries Open Pollination.
196 2A. ..	985	379	38	622	1.6	1.8
79a. 1A. ..	1,130	306	37	403	1.3	1.9
37b. 4A. ..	860	211	25	286	1.4	1.8
277a. 2D. ..	664	269	40	448	1.7	1.9
300a. 2A. ..	1,389	501	36	716	1.4	1.7
300b. 1B. ..	470	69	15	79	1.1	1.8
300b. 2F. ..	660	116	18	152	1.3	2.0
290c. 2B. ..	1,089	213	20	280	1.3	1.9
S. 1	669	175	26	265	1.5	—
S. 2	553	143	26	218	1.5	—

Once again, there has been a higher percentage of fertilisation than has been reported for *Robusta* coffee in other countries; but the differences between the figures in the penultimate and the last columns show that in a larger number of fruits only one seed developed from self pollination than was the case when the flowers were open pollinated. Some Java selections, planted out on Plot 29 in April, 1934, commenced to flower in September, 1935: several primaries were bagged and self pollinated, but only a very few fruits resulted; the work is being repeated in 1936, but again it seems that few fruits will be formed.

B. VEGETATIVE PROPAGATION.

9. *Grafted Trees*.—The grafted trees of *Robusta* coffee, planted out in 1932, have made fairly good growth and few more have died; in general, their condition is much better than that of the grafted *Arabica* coffee trees. The uniformity that is produced by grafting is becoming more strikingly shown; although in each clone *Robusta*, *Liberica* and *Excelsa* stocks were used, yet there is not very great variation between the trees in any one clone; while the differences between the clones, in the shape and colour of the leaves and the general habits of the trees, are very marked—for example, S26 clone has the dwarf spreading habit of the original tree, and S44 clone has the strong erect growth of that selection.

10. *Cuttings*.—Six more plants (five *Robusta* and one *Arabica* coffee) raised from cuttings struck in 1934, were planted out on Plot 29. Their growth was not quite so strong as that of the seedlings and they appeared to be more susceptible to the effects of drought than are seedlings of the same size.

C. EXPERIMENTS.

11. *Soil Treatment and Plant Growth Experiment*.—This experiment, started in 1933, was continued: the differences between the plots are becoming more marked—the trees on the plot on which the weeds are slashed are yellow and unhealthy: the coffee interplanted with *Centrosema pubescens* looks green and healthy during wet weather, but in dry periods the trees suffer, for they cannot compete with the cover crop for a supply of moisture: while in the clean weeded plot, and especially in the mulched plot, the coffee has made strong growth.

12. *Arabica Coffee Pruning Experiment* (Plot No. 3).—This experiment was commenced in 1927 and is a trial of three methods of pruning—Single Stem, Agobiada and Multiple Stem. The plot was planted with *Arabica* coffee (Nyasaland variety) in 1924 at a spacing of 10 feet × 10 feet and is shaded by rain trees (*Pithecolobium Saman*) spaced at 40 feet × 40 feet. The area is approximately one acre and it has been divided into 20 sub-plots—seven under Single Stem pruning, seven under Agobiada pruning and six under Multiple Stem pruning; the results are expressed as pounds of fresh cherry per sub-plot. The yields to date have been as follows:—

YIELDS PER SUB-PLOT (LBS.).

Method of Pruning.	1927—34.	1935.	Total.
Single Stem (A)	484.4	45.4	529.8
Agobiada (B)	747.6	78.4	826.0
Multiple Stem (C)	663.7	14.5	678.2

There are a certain number of blank spaces in the plot and the total number of trees in the heaviest yielding plots, those pruned by the Agobiada system, is 127: if the yield is calculated on the basis of the actual number of trees present, for the nine years 1927—35, these plots have yielded at an average rate of about 2,200 lbs. of fresh cherry, which would correspond to about 4 cwt. of dried coffee per acre per annum.

The plots under other treatments have given smaller yields, but it is obvious that, with these methods of pruning, a spacing of 10 feet $\times$ 10 feet is too wide, especially in the case of the bushes pruned on the Single Stem system, and it is probable that higher yields would have been obtained by closer planting.

13. *Robusta Coffee Pruning Experiment* (Plot No. 4).—The object of this experiment is to compare the yields obtained from *Robusta* coffee when it is subjected to the following methods of pruning:—

1. Single Stem.
2. Agobiada.
3. Costa Rica Multiple Stem.
4. Modified Costa Rica Multiple Stem.
5. Tree or open Multiple Stem.
6. Kinawa or Upright Stem.

The plot is nearly one acre in size, in 1930 it was planted with progeny rows from various selections of *Robusta* coffee, at a spacing of 8 feet $\times$ 8 feet. The various methods of pruning were commenced in 1931 and are laid down in lines across the progeny rows: there are four replications of each treatment but they are not randomised: individual tree records have been kept.

The coffee commenced to fruit in 1932, and the results to date have been:—

AVERAGE YIELDS OF FRESH COFFEE (in ozs.) PER TREE.

	1	2	3	4	5	6	
Year.	Single Stem.	Agobiada.	Costa Rica Multiple Stem.	Modified Costa Rica Multiple Stem.	Tree Multiple.	Kinawa or Upright Trunk.	Total.
1932	21	3	9	7	6	2	48
1933	154	169	133	120	145	145	866
1934	212	284	243	225	252	246	1,462
1935	111	234	212	193	183	205	1,138
TOTAL ..	498	690	597	545	586	598	3,514

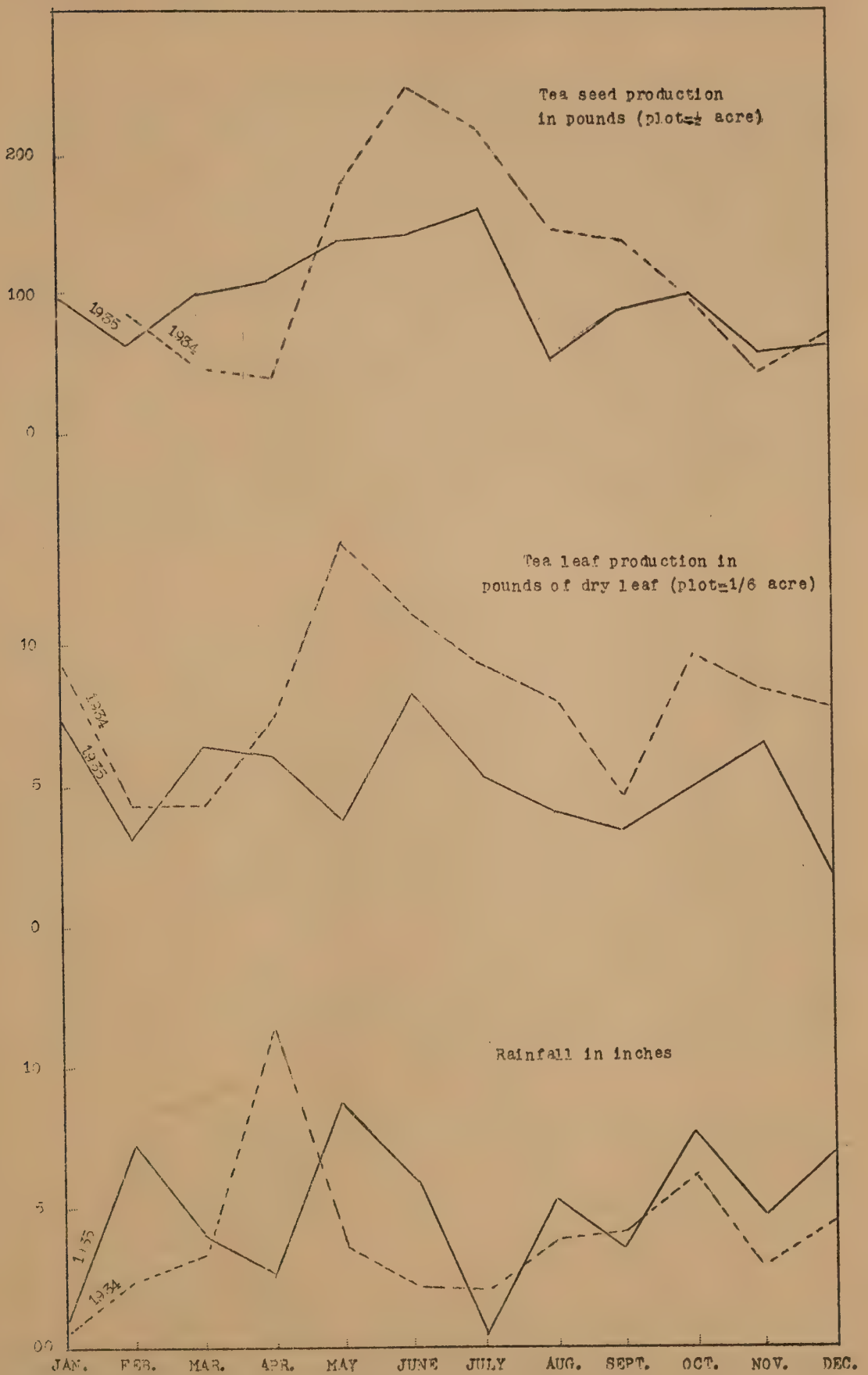
As the lay-out was not randomised, it is not possible to analyse these figures statistically: but it may be noticed that while the Single Stem method of pruning caused the production of slightly larger crops at first than did the other methods, it now seems to produce definitely smaller crops: while the Agobiada methods produced yields heavier than did the other treatments. The yield of this plot as a whole has been quite satisfactory: for example, the bushes under the Agobiada treatment within five years from planting have yielded at the rate of 29,300 lbs. of fresh cherry per acre: as the average ratio for this plot of dry beans/fresh coffee is 22 per cent., this corresponds to 6,450 lbs. of dry coffee=approximately 57 cwt.: in 1934 the yield of these bushes was at a rate of about 12,050 lbs. per acre of fresh cherry=approximately 26½ cwt. of dry bean: in 1935 the figures were 9,950 lbs. fresh cherry=approximately 19½ cwt. dry bean per acre. These high figures, in part may be explained by the close spacing of the coffee, and it is probable that the yield will fall off, for some of the trees, especially those pruned on the Multiple Stem systems and the "Kinawa" systems, have not room for their development.

D. ARABICA COFFEE.

14. In order that observation plots of different *Arabica* coffee varieties may be laid down in Ankole and Kigezi, material was supplied to the Agricultural Officers at Mbarara and Kabale. In April there were forwarded seedlings of Kent's *Arabica* and of selection 102 (local Nyasaland type) and, in May, seed of Harar and Blue Mountain varieties. It is hoped that other promising varieties may be added to these plots, and that a trial of different varieties may be laid down on the new experiment station in Toro. There was received from Amani seed of other interesting varieties of *Arabica* coffee—Mokka, San Ramon, Padang: some of this seed was forwarded to the Agricultural Officer, Bugishu, for sowing there, and the remainder was sown

FIGURE 1.

Tea leaf and tea seed production on Plot 32, Kampala Plantation 1934 & 1935.



at Kampala, together with some seed of *Coffea congensis*, also received from Amani. Twenty plants of each of Kent's *Arabica*, Harar, and Nyasaland varieties were planted at Kawanda for observation: and small segregated plots of Harar and Kent's *Arabica* were planted at Entebbe and Kitabi respectively to furnish supplies of seed of these varieties if it is required.

E. WILD COFFEE.

15. The study of the types of *Robusta* coffee growing wild in various parts of Uganda has been continued throughout the year. In February some wild trees in the Budongo Forest were inspected and in November the coffees in the Itwara Forest, Toro, and in the Bwamba Forest were again visited. In December a safari was made to the Imatong Mountains of the Southern Sudan, adjoining the Sudan—Uganda border, to inspect the wild coffee growing there: it was hoped that some wild *Arabica* coffee might be found, as the Imatongs are the mountain mass nearest to south-west Abyssinia, where *Coffea arabica* is wild: but no wild plants of this species were seen. Wild *Robusta* coffee, on the other hand, was common in some of the forests near the base of the mountains, at an altitude of 3,000—3,500 feet: in the Laboni Forest, only a few miles from the Uganda border, it was very abundant. This coffee is growing under conditions rather drier than that found in the forests of Uganda; and while, as is usual in wild *Robusta* coffee, there was considerable variation between the individual trees, yet on the whole it appeared to be a type with narrower leaves and longer fruits than those of most Uganda coffees. Seed of these coffees, and of wild *Robusta* from Bugishu, was collected and sown, for it is proposed to form a living collection of these wild types, and it is thought that the Sudan type may prove to be of value in parts of Uganda which are rather too dry for ordinary *Robusta* coffee. Rows of seedlings of wild *Robusta* coffees from the Mukono and Kibale forests, planted at Kawanda in the open, made poor growth, while a few seedlings, planted at the same time in a shady part of the Botanic Gardens, Entebbe, have done well: this difference in vigour is not surprising, for wild *Robusta* coffee in Uganda is always found in forests and not in the open.

TEA.

16. The tea on Plot 32 of the Kampala Plantation is an Assam Indigenous jat, planted in 1911: until 1931 the whole plot was plucked, but in that year a large portion of it was allowed to grow up in order that the trees might form seed bearers. In July, 1933, the small area (one-sixth of an acre) which was retained for plucking was drastically pruned and the trees in the seed-bearing plot (nearly one-half acre) were thinned—all the poorer types being removed. In Figure 1 there are shown in diagram form the yields for 1934 and 1935 of dry leaf from the plucked portion and the yields of seed from the seed bearing portion. It may be noticed that in 1934 the production both of leaf and of seed was greater than in 1935: in the former year the production of dry leaf was about 600 pounds per acre, while in the latter it was only 375 pounds—in both years the ratio of made tea/green leaf was 1/5. The diagram also illustrates that, in comparison with many other tea producing countries, there is a relatively small seasonal variation in leaf production, but that the peaks of leaf production usually occur in the month after one of heavy rainfall. With regard to seed production, although a considerable amount ripens in each month of the year, yet there is a definite maximum in the months of May, June, July.

In order to increase the area under seed-bearers a plot of about two acres under *Para* rubber, adjoining Plot 32, was cleared and sown with a cover crop of Velvet Bean; and seed of twenty of the best trees was collected separately and sown in order to provide a large quantity of seedlings on which vigorous nursery selection may be practised before planting.

ESSENTIAL OIL PLANTS.

17. Material for distillation was supplied to the Agricultural Chemist of the following:—

- Pelargonium pinnatum*.
- Pelargonium radula*.
- Rosmarinus officinalis*.
- Cymbopogon citratus*.
- Pogostemon patchouli*.
- Vetiveria zizanioides*.
- Chenopodium Botrys*.
- Chenopodium ambrosioides*.

The reports on the oils are given as an appendix to the Annual Report of the Agricultural Chemist: it may be noticed that all the reports were favourable, with the exception of those on *Pelargonium pinnatum* and the *Chenopodium* spp.

With regard to the *Patchouli*, it is interesting to note that the Imperial Institute report suggests that the recent samples of *Patchouli* oil were from a different stock than those which supplied the oil forwarded for report in 1931 and 1932: for such was the case—the earlier samples were from a stock of *Patchouli*, probably *Pogostemon Heyneanus*, imported from Ceylon in 1929, while the later ones were from a stock of true *Pogostemon patchouli*, imported from Singapore in 1933. Neither species flowers in Uganda, but there are marked differences in their vegetative characters—the *Pogostemon patchouli* has leaves less acute, less deeply serrated, and the stems, leaf veins and leaf edges are more strongly flushed with purple than is the case with *P. Heyneanus*: unfortunately the former species does not make such strong growth as the latter and it has suffered considerably from attacks by a *Pythium* sp.

As material became available, the propagation and planting of *Pogostemon patchouli*, *Aloysia citriodora*, *Vetiveria zizanioides*, *Mentha piperita*, *Pelargonium radula* (ordinary variety) and *Pelargonium radula* (French variety) was continued.

Sixteen seedlings of *Canangium odoratum*, whose flowers yield Ylang Ylang oil, were planted out on Plot 22, at a spacing of 30 feet triangular; these had been raised from seed imported from Singapore in 1934, and by December, 1935, they were four feet high.

18. It has been decided that other plants which have been under trial for essential oil production show little prospect of commercial value in Uganda; so the beds of them on Plot 17 were discarded and short lines were planted for retention on Plot 9; these plants included:—

Pelargonium pinnatum.
Pelargonium capitatum.
Pelargonium var. Attar of Roses.
Pelargonium fragrans.
Pelargonium odoratissimum.
Lavendula spp.
Coleus spp.
Ocimum spp.
Hoslundia opposita.
Polianthes tuberosa.
Thymus vulgaris.
Rosmarinus officinalis.

FIXED OIL PLANTS.

19. *Oil Palm*.—The seedlings of Nigerian selections, planted out in 1934, made strong growth: by the end of the year the leaves were 8—10 feet long. But the progeny rows of the heaviest yielding Entebbe palms, planted out later and in more swampy ground, were at first rather stunted; however, when the rains had stopped and the soil was drier, most of them made vigorous growth.

A surplus of seedlings had been raised and a quantity of those from Palm 12 at Entebbe (the heaviest yielder) were planted in the swampy ground at the base of the terraces (Plot 20) of the Kampala Plantation. The land is not ideal for oil palms, but they are more tolerant of wet conditions than almost any other crop in Uganda—the wild oil palms of the Semliki Valley grow in very swampy forests.

The investigation of fruit size, nut size and the kernel size of twenty of the highest yielding palms in the plot at Entebbe was completed during the year. In one palm the pericarp was 88% of the fruit, but in all others the percentage of pericarp was very low—ranging from 28% to 57%: while it has been laid down in the Congo that even for mass selection of oil palms the pericarp should be 75% of the fruit, or 65% in the case of very heavy yielding palms. The climate of Entebbe is cooler and drier than that of the main palm oil producing areas of the world: but it seems probable that this poor type of fruit is due mainly to genetical and not to climatic causes, for there are at Kampala three palms raised from seed of a high yielding selection in Malaya, and these palms produce fruits containing 58%, 68% and 62% of pericarp respectively.

Records of the yields of individual palms at Entebbe were continued: these records show that there is a definite seasonal variation in fruit ripening, with a maximum about the month of August (see Figure 2). In Figure 3 there is shown in histogram form the total yields of the Entebbe palms for the years 1927—35; during 1934 and 1935 a few palms produced as much as two or three hundred pounds of fruit per annum, but on the whole the yields are very low, for the age of the palms—they were planted in 1921.

FIGURE 2. Monthly yields of Oil Palm Plot at Entebbe.

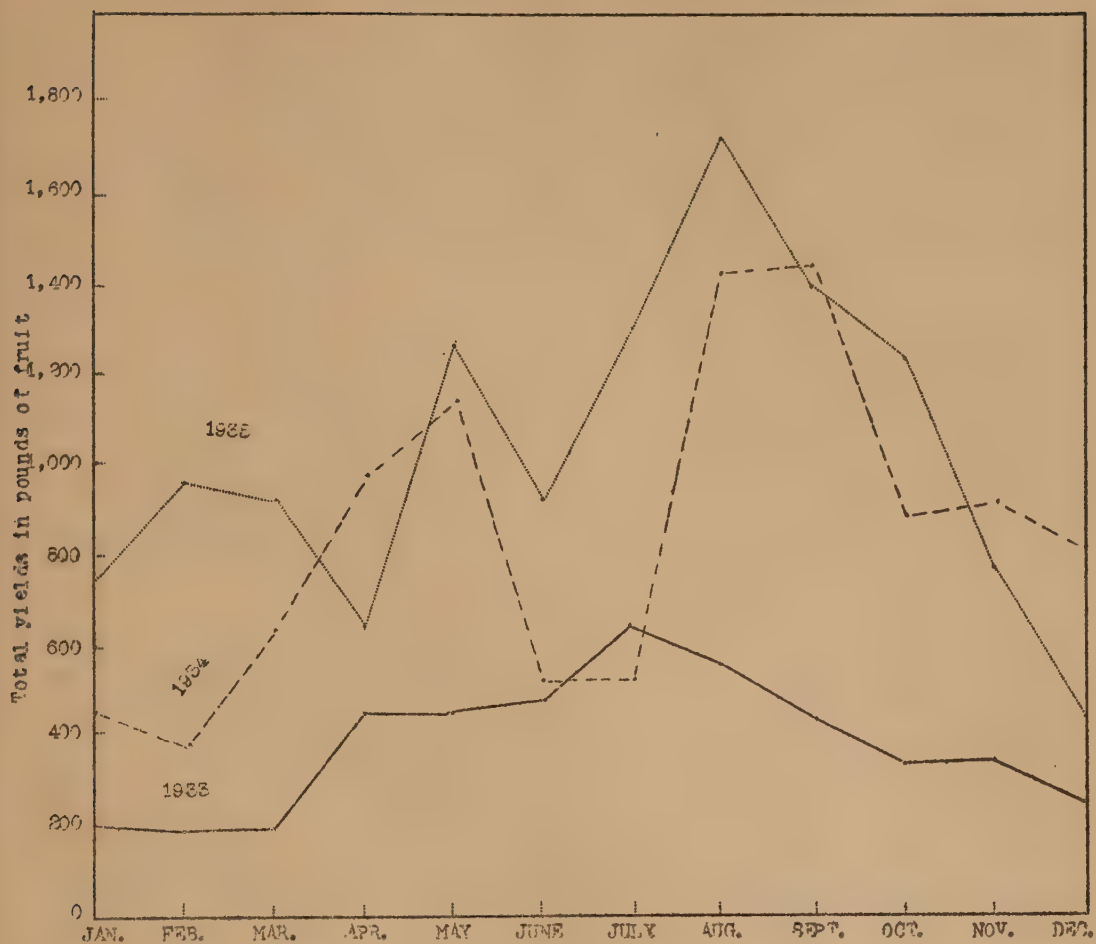
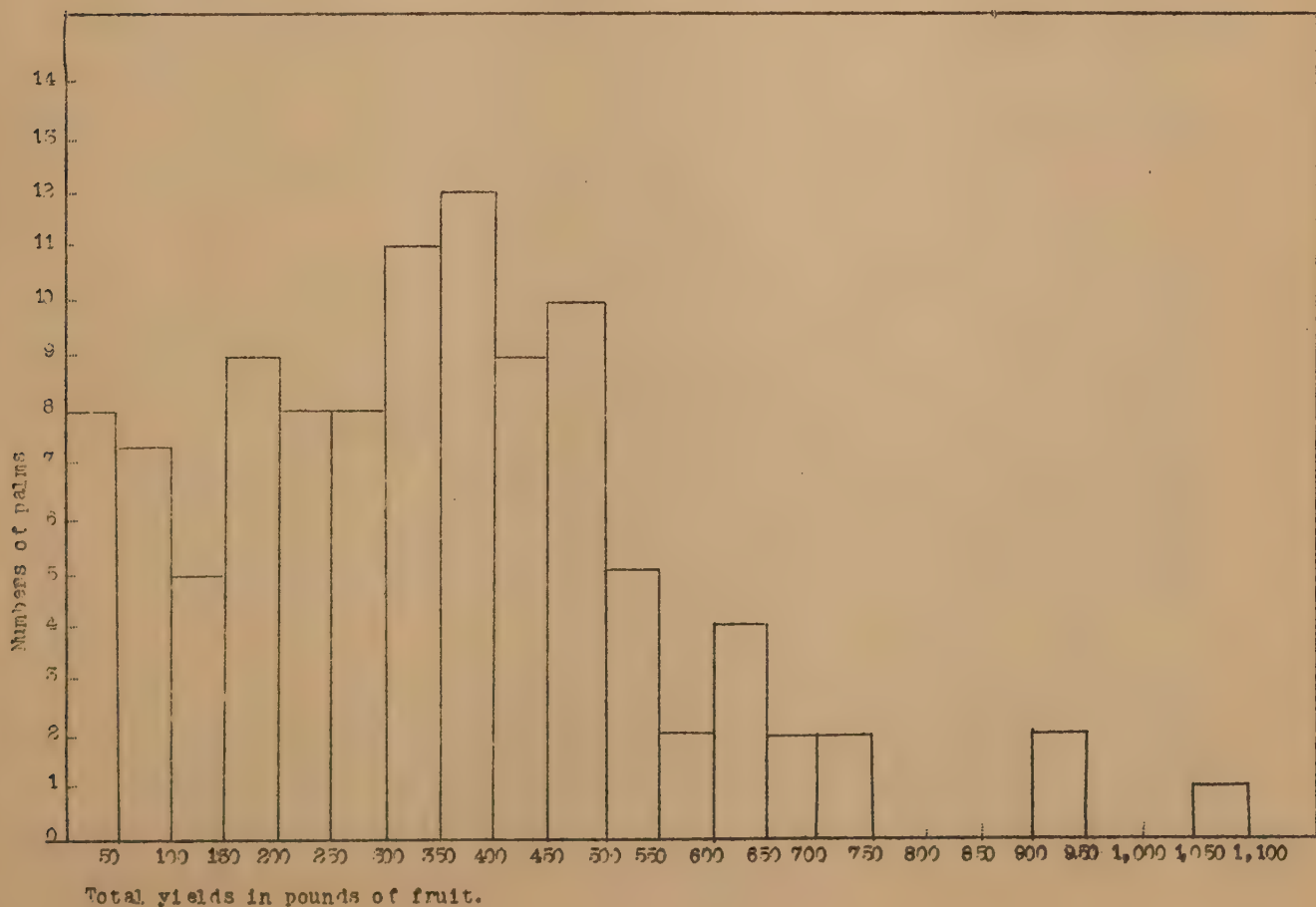


FIGURE 3. Yields of Individual Oil Palms at Entebbe 1937-35.



The more recently introduced varieties, however, show promise of yielding more heavily; one of the seedlings raised from a Malay selection and planted in 1928 is now fruiting well; and, as mentioned above, the progeny of the Calabar selections at Entebbe are making strong growth. It would seem probable, therefore, that more valuable results will be obtained by selection from these newer types than from the older block of palms at Entebbe. Until the young palms commence to bear fruit in quantity, all that can be done is to ensure that any seed that may be distributed is selected only from the best of the old palms; a bag of such seed was forwarded to the Agricultural Officer, Masaka, for preliminary trials in Buddu and the Sese Islands.

20. *Castor Oil*.—The work of selection was continued on this crop: a plot was sown on the Kampala Plantation with progeny rows of twenty-two selections from India and Bukalasa and seven selections from the plants grown at Kampala in 1934: the spacing was 8 feet $\times$ 7 feet. The fruits of the individual plants were harvested separately as they ripened, and notes were made on the vegetative characters of the plants. In some rows all the plants were so diseased that scarcely any crop was produced, but others fruited quite well: the various types showed marked differences in the time of fruiting—some produced a heavy first crop and little afterwards, while others continued to fruit well until they were uprooted, twelve months after the time of sowing.

FIBRES.

21. *Abroma augusta*.—The plants, raised from seed imported in 1934, made strong growth and in June they were ready for cutting. A few were cut down, the bark of the stems stripped—a very easy process—and handed to the Assistant Agricultural Chemist for retting. The samples of fibre were forwarded to the Imperial Institute and, as they received a favourable report (ref. the appendix to the report of the Agricultural Chemist) it was decided to lay down a trial plot of two acres. As seed became available it was sown at stake at a spacing of 3 feet $\times$ 3 feet; germination was very poor, perhaps partly because of the spongy nature of the soil—it was a reclaimed swamp; the plot was re-sown and towards the end of the year the seed was sown in nursery beds to raise seedlings for planting out in the blank spaces.

All the seed, previous to sowing, was soaked for forty-eight hours, for germination tests carried out in the greenhouse had shown that this process aided germination:—

A. Seed from bulk	...	...	...	...	...	39%
B. Seed from bulk, soaked 48 hours before sowing	...	...	...	...	...	43%
C. Seed freshly gathered from ripe fruits	...	...	...	...	...	39%
D. Seed freshly gathered from nearly ripe fruits	...	...	...	...	...	32%

While the percentage of germination was slightly greater in the case of the soaked seeds (Sample B) the process was much accelerated—these seeds commenced to germinate nine days after sowing, while the unsoaked seed did not grow until after thirty days.

22. *Manila Hemp*.—The Manila Hemp (*Musa textilis*) grown from suckers imported from Amani in 1933, has made good growth during the year and the area under this crop was increased by planting suckers from the older plants.

SPICES AND CONDIMENTS.

23. *Vanilla*.—As the vanilla vines had not made very robust growth on the existing plot, they were re-planted on a larger plot of *Gliricidia sepium* in one of the wetter parts of the plantation, Plot 33. The shade on this plot is denser than that of the former plot, but it may not be heavy enough for the vanilla, which grows best in forest conditions in Uganda—as may be seen on the plantation near Entebbe where good quality vanilla pods are now being produced.

24. *Japanese Chillies*.—The plot, raised from seed imported from England, ripened at the beginning of the year and plants were selected for seed purposes—twenty large fruited and eleven small fruited. Seed of these selections was sown at stake in progeny rows during February and re-sown in May, but the stand obtained was very poor: therefore more seed of the selections was sown in nursery beds and planted out in August at a spacing of 2 feet $\times$ 2 feet. The crop commenced to ripen at the end of December and twenty plants (ten large fruited and ten small fruited) were selected in February, 1936.

SUGAR CANE.

25. Six varieties of Sugar Cane, imported from Natal in 1933, have been propagated on the plantation and by September there was sufficient material available for them to be distributed to local sugar estates. The varieties were POJ 2946, POJ 2947, POJ 2952, POJ 2822, CO 281, CO 290: the former types were for planting on good soils, while it is thought that the latter may be superior to Uba cane for growing on poor soils. All the varieties have

made good growth, but the leaves of CO 281 are badly attacked by *Cercospora longipes*. Some of the material cut was used to fill up the plots of these varieties, and plots were planted with varieties introduced previously—POJ 2725, POJ 2727, POJ 2878.

GREEN MANURES AND LEGUMES.

26. A considerable number of green manure crops and other legumes were grown on the plantation including:—

Arachis hypogea (Groundnut).
Cajanus cajan (Pigeon Pea).
Canavalia ensiformis (Sword Bean).
Centrosema plumieri.
Centrosema pubescens.
Clitoria cajanifolia.
Crotalaria agatiflora.
Crotalaria alata.
Crotalaria intermedia.
Crotalaria juncea (Sunn Hemp).
Crotalaria natalensis.
Crotalaria recta.
Crotalaria sericea.
Glycine max vars. (Soya Bean).
Leucaena glauca.
Mucuna pruriens (Velvet Bean).
Phaseolus calcaratus.
Phaseolus lunatus vars.
Pisum sativum (Pea).
Pisum sp. (Wedge Pea).
Sesbania aegyptiaca.
Tephrosia candida.
Tephrosia vogellii.
Trifolium johnstonii.
Vigna unguiculata (Cowpea).
Voandzia subterranea (Bambara groundnut).

Of these, under conditions at Kampala, the most useful quick growing cover crops are sunn hemp, pigeon pea, velvet bean and sword bean: the two latter types were grown on a considerable scale. Selection of sunn hemp, in an attempt to produce a type with a more vigorous branching habit, was continued: progeny rows of selections made in 1934 were sown in February and singled to a wide spacing (3 feet × 2 feet), and from this plot twenty of the most vigorous plants were selected in April.

GRASSES.

27. The collection of grasses on the Kampala Plantation was maintained, and observation on various Uganda grasses was continued. Special notice was taken of the habits of elephant grass (*Pennisetum purpureum*), on whose growth depends largely the maintenance of fertility in many areas of Uganda. One interesting point was noticed—that elephant grass can compete successfully with Lumbugu (*Digitaria scalarum*) which is such a pernicious weed in this country: the soil on Plot 25 was exhausted and in parts it was a mass of Lumbugu: cuttings of elephant grass were planted all over the plot and after some months it had grown up, even in the places where the Lumbugu was thickest. This fact should be of value, for although Lumbugu is not completely killed by elephant grass, yet its growth is weakened so much that it will not be nearly so expensive to eradicate as in unshaded ground.

Attention was also devoted to French grass (*Cynodon Dactylon*) which is extensively used in Uganda for planting lawns and golf greens. Experience has shown that the French grass often dies out after a few years and that it is replaced by other coarser grasses: and that this degeneration is especially rapid when a coarse type of French grass is employed for the original planting. A strip was planted with stolons of fifty different patches of French grass growing locally and with some of a good type of *Cynodon Dactylon* supplied from the Scott Laboratories, Nairobi: it was seen that the various strains differed greatly in the rate of growth, the length of leaves, the colour, and the precocity of flowering; it is intended to raise seedlings of the better strains during the present year.

FRUIT.

28. *Citrus*.—Both at Kampala and at the Botanic Gardens, Entebbe, the propagation of introduced varieties of *Citrus* fruits (grape fruit, oranges and tangerines) was carried on as bud-wood became available: introduced trees of these varieties were pruned in order to stimulate the production of stronger shoots, which provide better buds for propagation. The stocks used were sour orange, pomelo and rough lemon; in most cases, with the exception of the tangerines, the buds took well; but the subsequent growth has been very poor on the pomelo and the sour orange stocks—the shoots have been chlorotic and stunted, probably owing to some nutritional deficiency, and in many cases both stock and scion have died. On the rough lemon stock, strong growth has been made in most instances and it would seem that this should be the most valuable stock in Uganda: it is said that trees on rough lemon stock often produce coarse fruits but, as it is improbable that there will ever be much export of *Citrus* from Uganda, this consideration will not be of much importance.

29. *Bananas*.—A study of the local types of bananas was made in an attempt to match them with descriptions and photographs of the varieties cultivated in Tanganyika. It was found that for complete description it would be necessary to keep the varieties under observation at the times of flowering and ripening of fruit and therefore a single sucker of each of fifty-one kinds, growing at Bukalasa, was planted on the terraces adjoining the fruit plot on the plantation here.

PAPERS.

30. A paper entitled "The effect of various treatments on the soil and on the growth of coffee" was written in collaboration with the Assistant Agricultural Chemist and was read at Coffee Planters' Days, Nairobi, in July. Another paper: "Some of the work in progress on Coffee" was read at the Jubilee Meeting of the Uganda Planters' Association in December. An article "Types of *Robusta* coffee and their selection in Uganda" was published in the November number of the *East African Agricultural Journal*.

INTRODUCTIONS.

31. Among the plants of economic importance that were introduced during the year, there may be mentioned:—

Coffea arabica vars. Series A and Blue Mountain from the Scott Laboratories, Kenya.

Coffea arabica vars. San Ramon, Mokka and Padang, and *Coffea congesta* from Amani.

Crotalaria sericea from I.N.E.A.C. Yangambi, Belgian Congo.

Grateful acknowledgment is made to those who kindly forwarded these seeds, and to the authorities in the Sudan for all their assistance during the safari to the Imatong Mountains.

A. S. THOMAS,

Assistant Botanist.

PART II.—ANNUAL REPORT ON THE BOTANIC GARDENS, ENTEBBE, FOR 1935.

The supervision of the gardens was carried out as in the previous year—they were visited by the Plantation Manager about once a week and on some occasions he was accompanied by the Assistant Botanist, Kampala.

2. METEOROLOGY.

Monthly summaries of meteorological records again were kindly supplied by the British East African Meteorological Service.

The total rainfall amounted to 62.54 inches, a figure 3.25 inches above the average. Although rain was recorded on 153 days, yet on the whole it was badly distributed and there were some very dry periods; January, with a total of 0.47 inches, was the driest month and May, with a total of 10.21 inches, was the wettest; the highest daily rainfall—6.26 inches—was recorded on November 13th.

Temperatures were below the average—the mean maximum was 78.3°F and the mean minimum 59.3°F; the highest temperature—84.8°F—was recorded on January 19th and the lowest—56.8°F—on July 1st.

3. LABOUR.

There was no difficulty in obtaining an adequate supply of unskilled labour; 70—75 men were employed each month. The labourers were drawn from several different tribes and included one gang of Nilotics who are superior to most local natives for heavier types of work, such as clearing and road-making. Porters usually were engaged at a wage of Shs. 11 or 12, and an increase was given after some months if their work proved to be satisfactory.

The clerk resigned in May and was replaced by Om. Reuben Sempagala, who was transferred from Kampala.

4. OIL PALMS.

The routine of harvesting and recording the individual yields of palms on the original plot (planted in 1921) was continued. On the whole the yields have not been very good—since the palms commenced to fruit in 1928, the highest total is 1,092 pounds of fruit from palm No. 12, and the second highest is 948 pounds from palm No. 1: and there are several palms which have yielded only a few pounds of fruit, while two have not fruited at all. Nor is the quality of the fruit very good—in the fruits of the highest yielding palms there is a low proportion of pericarp and the nuts are very thick shelled: this matter is discussed in the annual report of the Assistant Botanist, Kampala.

The seedlings of Nigerian palms, planted last year, have continued to make very good progress; but the progeny rows of our own best yielding palms, which were planted in lower, wetter soil, have not grown so well, although most of them are of a healthier, darker colour and are now beginning to go ahead.

One hundred seedlings were distributed for planting purposes and another seventy were used to extend the oil palm plot on the Kampala plantation.

5. *HYDNOCARPUS* SPECIES.

Hydnocarpus Wightiana.—The plants continued to make healthy growth, with a spreading bushy habit and, up to the present, no tendency to make a main trunk. Five more trees commenced to fruit during the year and there are now sixteen trees in bearing: the average number of fruits produced was 99 per tree: there was an average of 9.6 seeds per fruit—the maximum number recorded was 48.

Hydnocarpus anthelmintica.—This species has made rapid erect growth—some specimens are forty feet high and the habit is much more tree-like than that of *H. Wightiana*.

Seventeen trees are now in bearing, for fifteen commenced to fruit during the year: an average number of nine fruits per tree was recorded and the mean number of seeds per fruit was 35.6—the highest being 98.

6. PEPPER (*Piper nigrum*).

The vines, which were planted against *Hevea* rubber trees in 1933, have grown well and many of them are over thirty feet in height. There has been profuse flowering throughout the year, but no fruit has been formed.

7. TEA (*Thea sinensis*).

The small plot of Betjan tea, planted in the Botanic Gardens has made rather poor growth, in spite of being mulched and manured; and there have been many deaths during the year—in one instance at least, owing to an attack of root disease (*Armillaria mellea*). The plot of Dhonjan tea at Kitabi has been even more disappointing and the trees that are alive have made less growth than have those of the Betjan jat.

8. COFFEE.

Two small plots of varieties of *Arabica* coffee have been planted—Kent's *Arabica* at Kitabi and Harar at the Botanic Gardens; it is intended that all other *Arabica* coffee shall be removed from the vicinity of these plots in order that they may serve as sources of seed supply. Both plots were established well, and by the end of the year the plants were large enough for them to be bent over for training on the Agobiada system. The Harar variety has suffered quite badly from attacks of *Cercospora coffeicola*, which does little damage to the "Nyasaland" variety usually grown in Buganda.

It is hoped to form a living collection of types of wild *Robusta* coffee from the various forests in Uganda in the form of short rows on the slopes under *Hevea* rubber trees on the north side of the gardens: the two types, from the Mukono and the Kibale forests, which were planted early in the year, have made good growth.

FRUIT.

The site that was chosen for the new fruit plot is at the top of the gardens and it had a good depth of soil: unfortunately, this plot is intersected by the township drain which carries off the the storm water from a large part of Entebbe, but which is quite inadequate for the purpose—every time there is a good fall of rain the water overflows, and in consequence a great deal of soil has been washed away from the fruit plot. As a result, the growth of trees on the plot has been poor—some are very stunted, especially the budded *Citrus* trees.

A cover of grass (*Paspalum notatum*) has been established over part of the plot and this should control future erosion although, owing to the amount of soil that has been swept away, the plot is very uneven—in some places the subsoil was exposed. The upper portion of the plot alongside Berkeley Road, has been kept under a temporary cover of velvet beans (*Mucuna pruriens*) for it is of no use to attempt to establish grass there until the drain has been enlarged.

Specimens of a few more species were planted out on the plot during 1935, including three *Casimiroa edulis*, three *Coccoloba uvifera*, one *Flacourtia cataphracta*, one *Passiflora violacea* and one *Tacsonia Van Volxemii*; previous attempts to establish the latter species have failed, but this time a plant, already established in a tin, was put out.

NURSERY.

The process of transferring all the nursery work to the new site was completed during the year; in the new nursery, the plants are arranged in alphabetical order and grouped into various classes—annuals, herbaceous plants, bulbs, shrubs, climbers, roses, fruit trees.

The nursery headman retired during the year after a very long period of service in Botanic Gardens.

The propagation of *Citrus* varieties by budding was commenced during the year at Entebbe; as was the case at Kampala, it was difficult to obtain suitable budwood from the established trees; the varieties employed as scions include March's seedless grape fruit, Washington Navel and Pineapple oranges, and Emperor tangerine. A total of over two-hundred-and-fifty stocks were budded, but in only about one hundred cases was good growth obtained—the results were much better on the rough lemon stocks than on those of sour orange; while there was only a small proportion of success with tangerine buds on either of these stocks.

DISTRIBUTION OF PLANTS, SEEDS, ETC.

			Plants.	Seeds.	Cuttings.	Bundles.
Economic	..	..	1,869	9 pkts.	—	—
Decorative	..	..	5,467	89 pkts.	103	2
TOTAL	..	..	7,336	98 pkts.	103	2

In addition, 20 pounds of velvet beans and 20 ounces of *Cinchona* seed were supplied to European estates.

LAWNS AND FLOWER BEDS.

The routine cutting of the lawns was continued and the grass was kept reasonably short, except during very wet periods, when the machines could not be used: and many of the tufts of coarse grasses (for example, *Panicum maximum*) were dug out.

Six or seven acres of land at the bottom of the gardens, including that which was used as the old nursery, were cleared, levelled, weeded and planted with grass. This work required a great deal of labour, but the wet spell of weather at the end of the year was very helpful and a good cover of grass (a form of *Cynodon Dactylon*) was obtained.

Observation was continued on the eight plots of different grasses which were planted by the nursery to test their value for lawns: many of the finer grasses tend to be replaced by other plants and an uneven, poor lawn results: while two of the stronger species—*Paspalum notatum* and *Brachiaria decumbens*—are able to maintain a pure stand and therefore show promise of being more useful for lawns on a large scale, in spite of their rather coarse habit.

The various beds were kept filled with flowering plants—whenever possible, perennials were planted, for they usually ensure a more continuous show of colour; one or two beds were filled in and grassed over, for large beds tend to become unsightly, especially on sloping ground: it is intended to group the flowers in a long double border near the nursery.

ROADS AND DRAINS.

During the year several hundred yards of drains have been rebuilt and faced with ironstone, and strenuous efforts are being made to ensure the adequate drainage of the gardens and the absence of stagnant water. The work required a great deal of labour, for when the stone has to be quarried, shaped and carried for some distance, progress is very slow: towards the end of the year, however, a quantity of stone was supplied from buildings recently demolished in Entebbe, and in consequence it was possible to proceed more rapidly: thanks are due to the Township Authority and to the Public Works Department for the supply and transport of this stone.

In some cases the roads were also remade and gravelled; and one or two redundant narrow roads and paths were levelled and grassed over.

One new road was made—from the fernery down to the lakeside road: for it is intended to extend the Fernery in this direction and also, to eliminate some of the bad corners in the existing roads.

LABELLING OF PLANTS.

At the end of the year a start was made with the work of labelling the plants in the gardens. Xylonite labels, (size 5" x 3") are being used, and the names are painted in black Duco paint—it is hoped that such labels will prove to be fairly lasting. It is intended to show on the labels, whenever possible, the specific name, the family, the county of origin and the English or native name; also, in the case of trees, the year of planting.

INTRODUCTIONS.

One-hundred-and-forty-six species and varieties of plants were introduced during the year, most of them being decorative plants. This number includes seventy packets of seeds from the Singapore Botanic Gardens, from Amani and from Messrs. Vilmorin and Andrieux, Paris.

A valuable collection of eight varieties of orchids was presented by Messrs. Philpott, Bournier Co., Kitale, Kenya, and a considerable number of decorative plants was purchased from Kenya, including forty-two named varieties of Cannas.

Many of the plants introduced in recent years are proving themselves to be valuable additions to gardens in Uganda—for example, *Lavendula dentata*, *Musa coccinea*, *Cestrum* spp., *Alpinia nutans*, *Cuphea micropetala* and *Angelonia salicariaefolia* var. *alba*.

ENTEBBE FLOWER SHOW.

This was held at the Entebbe Club on May 26th. An exhibit of cut flowers, shrubs and newly introduced plants was staged on the verandah, and a number of plants were supplied for prizes.

ACKNOWLEDGMENTS.

For gifts of plants and seeds grateful thanks are expressed to Messrs. Philpott, Bournier Co., Kitale, Kenya, to the Botanic Gardens, Singapore, to the East African Agricultural Research Institute, Amani, and to various local residents.

P. CHANDLER,
Plantation Manager.

PART III.—BOTANICAL WORK, BUKALASA.

METEOROLOGICAL.

Once again abnormal weather conditions extended over a large portion of the period under review and as far as Bukalasa is concerned a considerable reduction in potential yield of cotton was the ultimate result. The general effect of the weather was to give further proof if any is still necessary of the value of early cotton planting; June is usually dry and July often so which means either May or August planting and the latter usually gives a low yield. This season May was abnormally wet with a total fall of over 10 inches. June was wetter than usual but July, when normally most of the experimental cotton is planted, was so dry that no planting was possible; the total fall for the month being only 0.48". Unfortunately August was also dry, the result being that germination was not general until the beginning of September. Later weather was normal until December which was very wet and January when an unusual number of overcast days caused a delay in ripening. This was followed by a very wet February which further retarded maturity, caused severe shedding, and damaged a great deal of ripe cotton. Regular pickings were impossible and the amount of rain-stained cotton was so great that proportions of fift were meaningless.

The cotton crop ripened well up to the end of March and in some cases the highest pick was not recorded until 25th March.

Tobacco was also badly affected by adverse weather conditions. The "Togo" crop was ruined by hail and wind and the "dumbi" crop was completely spoilt by a heavy storm on December 30th.

The following table summarises the meteorological records for the season under review.

TABLE 1.

Month.	Rainfall. Ins.	Highest Fall in One Day.	Number of Days Rain Fell.	Deviation From 14-year Mean.	Daily Sunshine (Hrs.)	Remarks.
1935.						
April ...	4.99	1.10	12	-1.78	6.1	Cold low maximum temperatures. Colder than usual,
May ...	10.70	1.38	16	+5.80	4.8	
June ...	4.69	1.40	20	+1.10	4.5	
July ...	0.48	0.20	4	-3.03	7.2	
August ...	2.13	0.59	1	-2.92	6.1	
September ...	3.15	0.55	9	-2.00	6.6	
October ...	6.50	1.37	20	-0.65	5.2	
November ...	2.76	0.87	10	-1.62	7.0	Very heavy storm on 30th.
December ...	6.32	2.85	12	+3.13	6.9	
1936.						
January ...	0.97	0.35	10	-0.60	5.6	Many cloudy days.
February ...	6.70	2.01	15	+4.46	4.3	
March ...	4.63	0.90	14	-0.31	6.6	

COTTON.

I. BREEDING PLOT.

This was planted at the normal time, *i.e.*, within the first ten days of July but unfortunately the weather conditions being abnormally dry an average stand of only 35% was obtained by August 9th. Hand watering was resorted to and the final stand after replanting was quite satisfactory.

The New Selection Series consisted of 53 lines, most of which were field selections from Local cotton; these were reduced to 34 at the time of picking and still further selection was done as the season proceeded. Nothing very outstanding was obtained except that the line U.B. 24/4, a derivative of U. 4/4/2 gave the longest and finest lint of any U. 4 derivative we have yet obtained in this country. This desirable lint character unfortunately does not appear to be correlated with Blackarm resistance or yield. Some indication of Wilt resistance is, however, present.

Owing to the serious aspect of Wilt disease, which is dealt with more fully under a separate heading, very rigorous selection for resistance was done and the writer is indebted to the Mycologist for examining every plant retained in the plot. The B. 180 and B. 181 groups were disappointing except in so far that their resistance to Blackarm was maintained; they were very late maturing and produced much vegetative growth. The B. 31 reselections did not exhibit any Blackarm resistance and have therefore been abandoned. The Local selections promised well but in nearly every case produced short and harsh lint thus justifying their eventual abandonment. B. 147/9/8 gave an excellent yield of rather short and harsh lint; this line is quite possibly a U. 4 derivative as it originated from a selection in the mixed plot.

Only selected U.B. 24/4 plants have been promoted to the Pedigree Lines for next season as there was nothing sufficiently outstanding amongst the remainder. B.P. 50 reselections were disappointing and were mostly susceptible to Wilt. B. 274's maintained their very erect habit and appeared to show rather less susceptibility to Blackarm than the original parent. The U. 4's in general appear to be more susceptible to Blackarm under Bukalasa conditions than they do at Serere—this applies equally to those included in the Pedigree Lines as well as those in the new selection series.

PEDIGREE LINES.

34 Lines were planted consisting of 4 main groups:—

- (1) B.P. 50 derivatives (Local Buganda selections),
- (2) B.P. 52 derivatives *via* B.P. 89 (Nyasaland selection),
- (3) S.G. 23/8 derivatives (Nyasaland selection Serere 1924), and
- (4) U. 4/4/2 families from Serere.

In the B.P. 50 group resistance to Blackarm showed an advance on that of the original parent. Differences in maturity were observed but for the most part this group is early maturing. The Wilt susceptibility is the most serious fault of the group as the lint characters are excellent in most lines. B.P. 112 and 115 were the best in the group both as regards Wilt, Blackarm resistance, yield and ginning outturn although their lint length only just exceeds the minimum.

In the B.P. 52 group only one line (B.P. 119) was retained but as a whole the group again showed evidence of toleration of Blackarm as despite relatively high numbers of lesions per plant the yields were high. Wilt was also less in evidence than in the B.P. 50 group.

With regard to the S.G. 23/8 group the lint lengths were disappointing and were all below 30 mm. Yields were good, especially B.P. 128; Blackarm was generally low and Wilt fair. In the U. 4's neither B.P. 138 nor B.P. 140 had any plants affected with "acute" Wilt but B.P. 140 had more Blackarm than any other selected line.

A negative correlation between lint length and ginning outturn is well presented in the three U. 4 lines. B.P. 140 is one of the most promising U. 4's that we have; at Bukalasa it yielded at a much higher rate than the other U. 4 lines. The tendency to production of "walnut" bolls was again pronounced in the U. 4's.

Generally speaking the lint length was short and was undoubtedly affected by the climate; most lines, however, were very uniform for length as is evidenced by the accompanying purity targets.

The Table below summaries the more important characters (quantitative) of those lines which have been retained.

TABLE 2.

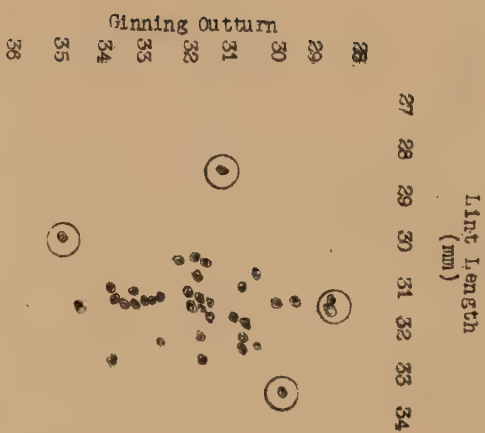
Group.	Line.	Number of Bolls per Plant.	Ginning Outturn.	Lint Length. (mm.)	Mean No. Blackarm Lesions per Plant.	Percentage Plants Attacked Acute Wilt.
B.P. 50	B.P. 106	18.7	30.6	31.5	0.3	35
	B.P. 107	18.8	30.5	31.0	0.4	28
	B.P. 108	21.1	30.3	31.9	0.5	23
	B.P. 112	26.4	32.2	30.4	0.2	16
	B.P. 115	24.3	31.7	30.7	0.2	14
B.P. 52	B.P. 119	28.3	31.5	31.4	1.6	2
S.G. 23/8	B.P. 125	28.0	32.9	29.4	0.1	9
	B.P. 128	32.0	32.2	28.2	0.4	4
	B.P. 131	22.5	31.2	26.9	0.1	5
	B.P. 132	23.2	29.8	29.9	0.05	10
U. 4/4/2	B.P. 137	18.5	37.5	27.6	0.1	3
	B.P. 138	16.3	36.2	28.2	0.2	0
	B.P. 140	28.8	34.2	29.3	2.1	0

PURITY TARGETS.

B.P. 116



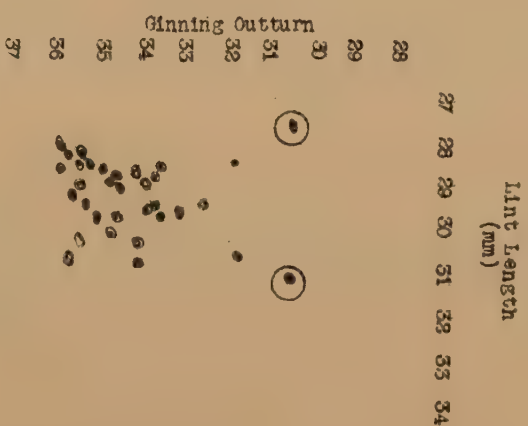
B.P. 119



B.P. 132



B.P. 140



The above diagrams demonstrate the purity of four of the Pedigree Linos for Lint Length and for Ginning Outturn. B.P. 115 and B.P. 140 are the most uniform. B.P. 119 is quite uniform for length but is still splitting for Ginning Outturn. B.P. 132 appears to be splitting for both characters despite ten generations of selection and selfing.

(Each dot represents a single plant. The ringed dots are those plants which are probably off-type).

REFERENCE PLOT.

The usual collection of varieties was maintained. No wilt-resistant forms were observed and even the native "Segamwenge" (*G. Brasilense*) was infected with the chronic form.

TRINIDAD HYBRIDS.

A further series of these was grown but all the plants were badly stunted and produced very short lint and have been abandoned.

BUKALASA HYBRIDS.

The F. 1's of a number of crosses made in the previous season were grown and in general their characters approximated to intermediates. Unfortunately all the back-crosses made failed to set as also did the new crosses, so that apart from F. 2's, the programme will have to be started again next season. The following table summarises the characters of some of the F. 1's.

TABLE 3.

Cross.	Origin.		Lint Length.	Ginning Outturn.
	♂	♀		
B. × 1	...	S.G. 23/8 × B.P. 75	...	32.4
B. × 3	...	" × " 4. B. 20	...	32.5
B. × 7	...	S.P. 39 × B.P. 96	...	28.9
B. × 8	...	B.P. 77 × B.P. 94	...	29.4
B. × 10	...		...	31.5
				32.3
				30.2
				33.2
				34.3
				30.2

It is noteworthy in the S.G. 23/8 × B.P. 75 crosses that the lint length of the latter has shown dominance while in one case the high ginning outturn of S.G. 23/8 is dominant and in the other it is not so.

INCREASE.

(a) A small plot of increase rows of some of the best pedigree lines of the previous season was grown to produce selfed seed. Of these B.P. 52 will be put into the 1½-acre increase plot next season.

(b) ¼-Acre.—(i) B.P. 89, a derivative of B.P. 52, was grown on this plot. It yielded at the rate of 734 lbs. per acre which was very satisfactory considering the very poor soil on which it was grown. Lint from this strain was classed as being slightly below its parent and in the miniature variety trial its yield was similar to B.P. 52.

No acute Wilt was observed in this plot, but Blackarm was rather severe for the season.

(ii) A ¼-acre plot of B.P. 104 (from S.G. 23/8) was grown at Kawanda. It yielded at the rate of 376 lbs. per acre which was good for August planting. Its lint has been classed as almost the best we have. Its yield in the Miniature Variety Trial was no better than S.G. 23/8 and its ginning outturn is only just over 28% so that it is not a very promising line except for quality.

(c) 1½-Acre.—This was sown with B.P. 79, a B.P. 50 derivative which promised well in the previous season. Wilt in both forms was prevalent but not nearly to the same extent as in B.P. 50. It yielded at the rate of 877 lbs. per acre. Its lint is excellent and its ginning outturn was high (33.17%). It was also less susceptible to Blackarm than B.P. 50.

(d) Main Increase 18 Acres.—B.P. 50 was grown on this area as it promised so well in the previous season. Unfortunately it suffered very severely from Wilt in the acute form and on this account alone it must be abandoned. Very unexpectedly it failed in the spinning tests although it was well liked by the graders. The yield over the whole area was 376 lbs. per acre; this low yield being due mainly to late planting as the 6 acres planted in May—June yielded well over 500 lbs. per acre.

VARIETY TRIALS.

1. MINIATURE VARIETY TRIAL.

This experiment designed to obtain some comparative yield figures from new varieties which have not reached the increase stage, consisted of 144 one-row plots of 12 varieties replicated 12 times. Each row consisted of 24 plants.

The following results were obtained:—

TABLE 4.

Variety.	Blackarm Lesions per Plant.	Yield Seed Cotton. Lbs. per Plot.
B.P. 50 Group.		
B.P. 50	0.53	1.01
B.P. 78	0.42	1.49
B.P. 52 Group.		
B.P. 52	1.06	1.36
B.P. 89	1.29	1.18
S.G. 23/8 Group.		
S.G. 23/8	0.52	1.08
B.P. 98	0.15	0.82
B.P. 104	0.45	1.19
U. 4/4/2 Group.		
S.P. 13	0.20	1.17
S.P. 43	0.14	1.21
S.P. 56	0.17	0.87
N. 17	0.99	0.59
Local	0.50	0.95
Least Significant Difference	0.18	0.26

As regards Blackarm, B.P. 50 was similar to Local but, as expected, the B.P. 52 group showed a higher infection than any other variety except N. 17. It is interesting to note that B.P. 89 was worse in this respect than its parent, B.P. 52. B.P. 98 showed high resistance while the others of the S.G. 23/8 group were equal to Local. The U. 4/4/2's were equal to B.P. 98.

In yields B.P. 78 was better than all except B.P. 52 which in turn was better than 23/8, B.P. 50, Local, N. 17, S.P. 56 and B.P. 98. S.P. 43 was better than Local and all were better than N. 17 except B.P. 98. The varieties which were also included in the main variety trial, *i.e.*, Local, B.P. 50, B.P. 52, S.G. 23/8 have obviously re-acted differently in this trial as here B.P. 50 was only equal to Local and S.G. 23/8 whereas in the main variety trial it was definitely superior.

2. MAIN TRIAL AT BUKALASA.

Seven varieties were tested against Local in a standard 8' x 8' Latin Square. They were:—

- B.P. 50 (Local selection *via* B. 37).
- B.P. 75 (*Ex* B.P. 50).
- B.P. 79 (*Ex* B.P. 50).
- B.P. 52 (N. 3/5 selection *via* B. 42).
- S.G. 23/8 (Nyasaland origin).
- B.P. 96 (S.G. 23/8 origin *via* B.P. 58).
- B.P. 102 (S.G. 23/8 origin *via* B.P. 59).

Owing to lack of rain planting was not done until August 22nd, which was 6 weeks later than usual.

Germination was good and no varietal differences were observed.

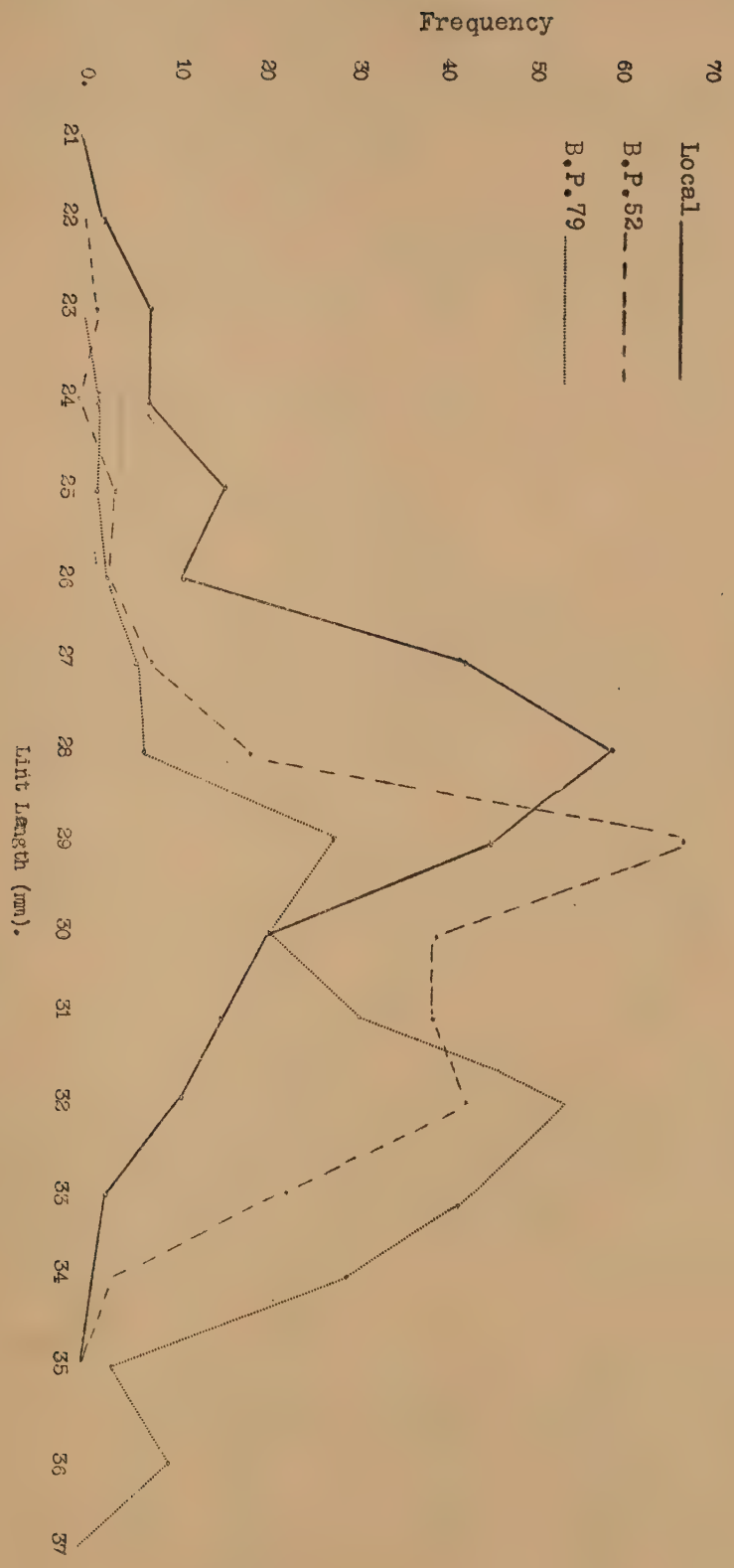
Habit.—The B.P. 50 group had outstandingly more erect and storm-resistant habits than the other varieties. Local varied considerably as is to be expected in such a mixed crop. S.G. 23/8 and its derivatives were very badly lodged and picking became quite a difficult task.

A *Blackarm Count* made by Omw. Mukasa in December showed considerable differences between the varieties. The figures for lesions per plant being as follows:—

TABLE 5.

Variety.	Lesions per Plant.
B.P. 75	1.44
B.P. 79	2.42
B.P. 96	3.38
B.P. 102	4.34
Local	5.86
S.G. 23/8	6.04
B.P. 50	7.10
B.P. 52	11.84
L.S.D.	1.60

LINT LENGTH CURVES.
 BUKALASA VARIETY TRIAL.



These results are of considerable interest as the derivatives of B.P. 50 and of S.G. 23/8 both show less Blackarm than the original parents.

B.P. 75, B.P. 79 and B.P. 96 all show an improvement as compared with Local. And all varieties including Local have significantly less Blackarm than B.P. 52. As is seen later, despite a heavy Blackarm infection B.P. 52 produced the highest yield.

Lygus counts were made without showing any varietal difference.

Maturity.—The importance of earliness was more evident than ever this season with such late planting, and similarly to last year, B.P. 52 produced the bulk of its crop earlier than Local. The following were the dates of the picking peaks.

TABLE 6.

<i>Variety.</i>		<i>Date of Picking Peak.</i>
B.P. 52	...	Feb. 12.
B.P. 75	...	
B.P. 50	...	Feb. 19.
B.P. 79	...	
B.P. 102	...	
Local	...	March 4.
S.G. 23/8	...	
B.P. 96	...	March 19.

It will be noted that B.P. 102 represents a considerable advance on its original parent S.G. 23/8 in this respect. The B.P. 50 group is generally early also.

The following table shows the percentage of the total crop produced by February 12th and by February 26th. The lateness of S.G. 23/8 is outstanding and despite having the same picking peak date it is obviously later than Local.

TABLE 7.

<i>Variety.</i>			<i>Percentage of Total Crop Harvested by</i>	
			<i>February 12th.</i>	<i>February 26th.</i>
Local	...	...	31	53
S.G. 23/8	...	...	21	49
B.P. 50	...	...	33	63
B.P. 52	...	...	37	66

YIELD.

As referred to under Maturity, B.P. 52 and B.P. 75 produced early crops. The picking curves were normal except for a considerable second and unexpected peak in March. Owing to heavy rain which fell in February the amount of "fif" cotton was unduly high and the figures are not given as they do not represent true varietal differences.

Results are worked out for: (a) Total Seed Cotton, (b) Lint, and (c) Ginning Outturn.

They are tabulated and discussed below:—

TABLE 8.

<i>Variety.</i>			<i>Seed Cotton. Lbs. per Acre.</i>	<i>Lint. Lbs. per Acre.</i>	<i>Ginning Outturns.</i>	<i>Lint Length. (mm).</i>
B.P. 52	...	...	1,389	445	31.90	30.18
B.P. 75	...	...	1,271	400	31.43	31.42
B.P. 50	...	...	1,220	387	31.99	31.39
B.P. 79	...	...	1,210	406	33.17	31.79
B.P. 102	...	...	1,075	348	32.33	28.22
Local	..	...	843	262	30.94	28.07
S.G. 23/8	...	...	758	252	33.36	28.95
B.P. 96	...	...	722	244	33.71	—
Least Significant Difference			128	441	0.65	—

The yields of Seed Cotton show B.P. 52 to have given a significant increase over all except B.P. 75; the B.P. 50 group to have given an increase over all except B.P. 52; and B.P. 102 to be better than either Local or its original parent S.G. 23/8.

With regard to Lint yields the results are for all practical purposes the same except that B.P. 79 is equal with B.P. 52 having replaced its brother B.P. 75 on account of its superior ginning outturn.

An analysis of Ginning Outturn was carried out and the results are interesting as B.P. 79, B.P. 96 and S.G. 23/8 have shown significantly higher ginning percentages than the other varieties; the success of B.P. 79 in this respect is encouraging. B.P. 102 is better than the remaining varieties except B.P. 52 thus all the 23/8 group have continued to show better ginning percentages than Local. In fact, Local is significantly lower than all varieties except B.P. 75.

The general conclusions deducible from this trial are that in a season similar to the one under review an early maturing variety is particularly valuable. In this respect it is interesting to compare this season's yields with those of last.

TABLE 9.

<i>Variety.</i>		<i>Yield per Acre 1934/35.</i>	<i>Yield per Acre 1935/36.</i>
Local	...	1,476	843
S.G. 23/8	...	1,348	758
B.P. 50	...	1,476	1,220
B.P. 52	...	1,420	1,389

Thus whereas Local and S.G. 23/8 have lost a large part of their yield, the other two varieties have suffered a much smaller reduction on account of maturing early.

With regard to quality of lint, B.P. 79 is outstandingly the best with B.P. 52, B.P. 50 and B.P. 75 next. The others are short, especially Local, but of these B.P. 102 is remarkably uniform. Local is very mixed but it is a little longer than last season whereas S.G. 23/8 and B.P. 52 are slightly shorter.

DISTRICT VARIETY TRIALS.

The Centres for the District Variety Trials were the same as the previous year with the omission of Nakifuma and Makurubita and the addition of Kalungu (Masaka District) and Bukalasa.

At all Centres the same varieties were grown in 4' x 4' Latin squares; the varieties being: Local, S.G. 23/8, B.P. 50 and B.P. 52.

The general results from these variety trials are much more reliable than hitherto as an observer is now stationed at each Centre to supervise all operations.

The table below summarises the results, none of which were significant.

TABLE 10.—YIELD OF SEED COTTON IN LBS. PER ACRE.

<i>Centre.</i>		<i>Local.</i>	<i>S.G. 23/8.</i>	<i>B.P. 50.</i>	<i>B.P. 52.</i>	<i>Sowing Date.</i>
Mengo District.						
Bukalasa	.. ..	530	556	789	780	September.
Kalagala	.. ..	1,400	1,340	1,270	1,280	July.
Mukono	.. ..	999	925	1,085	950	July.
Entebbe District.						
Kitala	.. ..	632	551	565	500	June.
Kabasanda	.. ..	1,350	1,124	1,415	1,124	June.
Nkozi	.. ..	525	416	362	330	July.
Masaka District.						
Kyanamukaka	.. ..	1,220	1,190	1,260	1,190	July.
Kalungu	.. ..	105	140	140	280	September.
MEAN	.. ..	844	780	856	811	..

TABLE 11.—YIELD OF LINT IN LBS. PER ACRE.

Centre.	Local.	S.G. 23/8.	B.P. 50.	B.P. 52.
Bukalasa	163	185	252	248
Kalagala	446	439	390	399
Mukono	297	310	338	305
Kabasanda	406	364	434	352
Nkozi	148	127	104	106
Kyanamukaka	367	389	398	382
Kalungu	32	47	45	93
MEAN	266	266	280	269

The depressing effect of late sowing is clearly emphasised at Kalungu and Bukalasa. There are no varietal differences but B.P. 52 appears to show its early maturing characters by giving the highest yields at Kalungu and second highest at Bukalasa where the trials were very late sown.

The following tables show the results of Blackarm counts at some of the centres. Both B.P. 50 and B.P. 52 are outstanding in the amount of infection but B.P. 52 has power of throwing off main stem infection under certain conditions and despite the heavy infections as compared with Local the yields are as high as Local. By far the heaviest infection was at Kitala where soil conditions were very poor. The results in general showed that Local had less infection than the other three, S.G. 23/8 less than B.P. 50 and B.P. 52, and B.P. 50 less than B.P. 52.

TABLE 12.—NUMBER OF LESIONS PER PLANT.

Centre.	Local.	S.G. 23/8.	B.P. 50.	B.P. 52.	Significant Difference.
Kalagala	0.006	0.025	0.062	0.042	—
Mukono	0.092	0.079	0.202	0.280	0.122
Kitala	0.289	0.632	0.764	1.196	0.569
Kabasanda	0.014	0.025	0.055	0.050	—
Kyanamukaka	0.051	0.072	0.088	0.261	0.124
5 Centres	0.090	0.166	0.234	0.366	0.100

The spread of infection through the plants appeared to be most rapid in B.P. 50 and slowest in S.G. 23/8.

SPACING AND VARIETY TRIAL.

A combined Spacing and Variety Trial using B.P. 50 and Local as the varieties and $4' \times 1\frac{1}{2}'$ and $3' \times 1'$ as the spacings was started at Bukalasa this season.

The layout was in the form of 6 random blocks. No differences between the varieties occurred either in Blackarm infection or in final yields but the closer spacing resulted in a significant increase in Blackarm lesions per plant as well as an increase in yield. There was a significant interaction between spacing and variety in that B.P. 50 had less Blackarm infection at the closer spacing than Local. This was probably due to its erect and trim habit.

TABLE 13.—BLACKARM COUNT. LESIONS PER PLANT.

	$4' \times 1\frac{1}{2}'$	$3' \times 1'$	Mean.
Local	0.31	0.66	0.49
B.P. 50	0.36	0.44	0.40
Mean	0.33	0.55	—

TABLE 14.—YIELDS. SEED COTTON PER ACRE (LBS.).

	$4' \times 1\frac{1}{2}'$	$3' \times 1'$	Mean.
Local	621	769	695
B.P. 50	563	757	660
Mean	592	763	—

Least Significant Difference 89.

The closer spacing 3' × 1' has consistently given a significant increase in yield over the standard spacing and for similar conditions to those obtaining at Bukalasa a spacing of 3' × 1' could be recommended in place of 4' × 1½' with the expectancy of a 12% increase in yield. The question of reaction to sowing date arises as it is quite possible that in the case of early sowings the much greater vegetative development of the plant might need a wider spacing.

BROKERS' TESTS AND SPINNING REPORTS.

We are greatly indebted to Messrs. Wolstenholme & Holland for reporting on lint samples and to the Indian Central Cotton Committee and the Shirley Institute for conducting spinning tests on our new varieties.

BROKERS' REPORTS.

The following table summarises the results of Messrs. Wolstenholme & Holland examination:—

TABLE 15.

Variety.	Length of Staple.	Strength.	Value.	Points on Futures (American 5·87).
Bukalasa.				
B.P. 50	1 $\frac{3}{8}$. Rather irregular	Medium to strong	7·12	125
B.P. 52	Full 1 $\frac{1}{8}$	Medium ...	6·97	110
S.G. 23/8	Good 1 $\frac{1}{8}$ irregular ...	Medium ...	6·57	70
Local	Full 1 $\frac{1}{8}$	Strong ...	6·87	100
Entebbe.				
B. 37 (Parent of B.P. 50)	Good 1 $\frac{1}{8}$ —Full 1 $\frac{1}{8}$...	Medium to strong	6·77	90
S.G. 23/8	Good 1 $\frac{1}{8}$ Full 1 $\frac{1}{8}$ irregular	Medium ...	6·67	80
Local	Good 1 $\frac{1}{8}$ Full 1 $\frac{1}{8}$...	Medium to strong	6·2	95
Mukono.				
B. 37	1 $\frac{1}{8}$ mixed with short	Medium ...	6·97	110
S.G. 23/8	Full 1 $\frac{1}{8}$	Strong ...	6·97	110
Local	Full 1 $\frac{1}{8}$	Medium ...	6·77	90

B.P. 50 is the best sample. Place effect is interesting, the poorer conditions at Entebbe reducing the premium in the case of Local and B. 37 (similar to B.P. 50). S.G. 23/8 is as usual marked down but again is best in the spinning tests.

The Indian Central Cotton Committee's Grader's report is summarised as follows:—

TABLE 16.

Variety.	Length.	Strength.	Value Above or Below Contract.	Basis.
Nkozi.				
B. 37	1 $\frac{1}{32}$ "	Good ...	Rs. 122 "on"	Rs. 208.
Local	1 $\frac{1}{32}$ "	Good ...	Rs. 125 "on"	" "
Makurubita.				
B. 37	1"	Moderate ...	Rs. 110 "on"	" "
Local	1"	Moderate ...	Rs. 112 "on"	" "

Place effect is again noticeable and rather surprisingly Nkozi gives a longer staple than Makurubita. B. 37 is slightly poorer than Local.

SPINNING TESTS.

The Shirley Institute reported *inter alia* "Of the Bukalasa samples B.P. 52 is the longest and has the lowest hair weight per centimetre . . . all the samples are rather immature B.P. 52 being the worst in this respect and B.P. 50 . . . the least immature. B.P. 50 is longer than either Local or S.G. 23/8."

The Entebbe and Mukono samples showed place effect in that at Mukono S.G. 23/8 and Local have considerably lower hair weights than at Entebbe while the hair weight of B. 37 is higher at Mukono than Entebbe.

"From the measured hair characters B.P. 52 (Bukalasa) and S.G. 23/8 (Mukono) would be expected to give the strongest yarns though B.P. 52 was actually surpassed by S.G. 23/8 (Bukalasa), and S.G. 23/8 (Mukono) was equalled by S.G. 23/8 and B. 37 (Entebbe)."

TABLE 17.—HAIR CHARACTERS (BUKALASA SAMPLES).

Variety.	Length Characters.		Immaturity.		Mean Hair Weight per cm. 10^{-5} mgm.
	Mean. mms.	% Short Hairs.	% Normal Hairs.	% Dead Hairs.	
B.P. 50	24.6	26	46	13	156
B.P. 52	25.4	25	29	29	138
S.G. 23/8	24.6	20	42	19	159
Local	25.4	17	38	17	177

SPINNING TEST.

"Thus on the whole S.G. 23/8 (Bukalasa) is the best as it is good in both strength and appearance. . . . of the remaining samples B.P. 50 (Bukalasa) and B. 37 (Mukono) though of fairly good strength are very neppy in both 50's and 64's, a fault which is to some extent shown also by B.P. 52 (Bukalasa) . . . and which renders these samples undesirable in spite of the strength achieved. The Local (Bukalasa) is satisfactory in appearance but of comparatively poor strength The Bukalasa sample of B.P. 50 although stronger than the Local sample is much inferior in appearance and is also inferior in strength and appearance to S.G. 23/8 (Bukalasa)."

TABLE 18.—SUMMARY OF SPINNING TEST.

50's Spinning. Sample.	Waste % Total.	Actual Count.	Lea Strength. Lbs.	Count × Strength.	Highest Standard Count.
Bukalasa.					
B.P. 50	11.3	50.0	43.0	2150	60—62
B.P. 52	10.3	50.5	43.8	2212	67—69
S.G. 23/8	9.9	51.9	46.2	2398	71—73
Local	10.3	50.4	39.4	1986	48—50
Entebbe.					
B. 37	11.7	50.1	49.3	2470	79—81
S.G. 23/8	11.7	50.5	48.5	2449	73—75
Local	10.4	51.0	41.9	2137	58—60
Mukono.					
B. 37	13.1	51.0	40.6	2071	56—58
S.G. 23/8	12.9	50.9	47.9	2438	75—77
Local	11.7	49.7	42.1	2092	53—55

It is disappointing that the appearance of B.P. 50 spoils it as its strength is so much superior to Local. S.G. 23/8 has maintained its superiority to Local but apart from appearance it is nearly equalled by B.P. 50 and B.P. 52 which is satisfactory in that we have not previously been able to produce varieties giving yarns of anything like the strength of S.G. 23/8. The figures for Highest Standard Count demonstrate the inferiority of Local.

The Indian Central Cotton Committee's report on the spinning tests show that Local at both Nkozi and Makurubita yields stronger yarns than the B. 37 samples. The B. 37 (Nkozi) had the same mean fibre length and fibre weights per inch as Local (Nkozi) but B. 37 (Makurubita) were 6% longer and rather finer than Local (Makurubita).

TABLE 19.

Sample.	Total Waste. %.	Counts.	Lea Strength.	Count × Strength.	Highest Standard Warp Count.
Nkozi.					
B. 37	14.2	30's 40's 50's	64.6 45.6 32.2	1964 1778 1571	50's
Local	13.8	30's 40's 50's	70.2 44.8 33.4	2113 1837 1660	50's
Makurubita.					
B. 37	14.2	30's 40's 50's	65.9 43.6 30.0	1977 1709 1521	50's
Local	...	30's 40's 50's	70.8 41.4 30.5	2067 1735 1549	50's

The general results show that Local is superior to B. 37 and that despite its irregularity it still spins well. It is noticeable that the Indian spun samples are much weaker than those spun at Shirley.

It would appear that B.P. 50 is superior to its parent B. 37 which is no improvement on Local. Further samples of B.P. 50 will be submitted as it is possible that some of its poor appearance may have been due to bad ginning.

Local does not spin so badly as we might be led to believe from examination of lint samples and from various reports which appear in the press, but it is certainly very inferior to S.G. 23/8.

SEED COTTON SAMPLES.

The routine analysis of seed cotton samples obtained from selected ginneries was carried out. The outstanding feature was the shortness in staple of the average Buganda sample. The Buganda samples were, however, more uniform than they used to be and it is possible that the longer stapled strains are gradually disappearing. Mubende appeared to have more longer stapled cotton than other parts of Buganda.

The samples from Bunyoro and West Nile where S.G. 29 is grown formed a striking contrast to the Buganda samples—the staple was much more uniform and generally longer and silkier.

The results are summarised below:—

TABLE 20.

District.			Lint Length. mm.	Ginning Outturn.
Mengo	...	...	27.56	29.8
Masaka	...	...	27.45	30.5
Entebbe	...	...	27.55	30.8
Mubende	...	...	28.23	28.9
Bunyoro	...	...	28.86	32.6
West Nile	...	...	29.78	29.8

COTTON PESTS AND DISEASES.

Wilt (Fusarium Vas-infectum).—The spread of this disease has reached alarming proportions at Bukalasa and it is now of greater importance than Blackarm as far as the west of the Nile area is concerned. The Mycologist has examined a tremendous amount of material in the breeding plot and other experiments at Bukalasa and Wilt resistance is now an additional urgent problem for the Breeding Section to deal with.

There appears to be grounds for the assumption that S.G. 23/8 is somewhat resistant and B.P. 52 also; but B.P. 50 and its derivatives appear to be very susceptible which is a serious matter as this group is the one most likely to provide the improved lint so urgently required in Buganda.

The Wilt plot which has been heavily infected with diseased material for two seasons will provide a useful testing ground for new varieties and also may enable some resistant selections to be made. The breeding plot was artificially infected by digging-in large numbers of infected plants from the B.P. 50 plot and the number of plants actually free from any sign of the disease was under 50, i.e., about 2%.

Blackarm.—This disease was not nearly so severe as in the previous season, and except for susceptible varieties such as B.P. 52, little reduction in yield occurred as a result of blackarm. It seems likely that a number of resistant strains exist in Local cotton and many of these have already been selected. B.P. 50 still showed signs of splitting for resistance and its derivatives were generally superior to it in this respect.

Helopeltis.—Caused severe damage at Nkozi where it has been reported previously. Undoubtedly the poor soil and climatic conditions in this area encourage the incidence of this pest. The $\frac{1}{4}$ -acre plot of B.P. 89 at Bukalasa was attacked; this plot suffers from *Helopeltis* every year.

Jassids.—These pests were present in large numbers at the Kitale variety trial and it was reported that S.G. 23/8 showed signs of being more severely attacked than the other varieties.

Lygus.—Damage was not severe this season.

Spiny Bollworm.—A considerable amount of damage was done by this pest at Bukalasa. This insect would appear to be a major pest every year and must cause a considerable reduction in crop.

SEED FARM AREAS.

A further survey of the Entebbe Peninsular was made. Owing to the proximity to Entebbe township the cotton acreage is liable to serious fluctuations and some doubts as to its suitability for seed farm purposes now arise. A survey of Mumyuka of Bugerere is being undertaken next season as this gombolola might form a possible extension area. It is very easily segregated and could be comfortably supplied with seed from the Kawanda seed farm.

SIM-SIM.

This crop is not proving an easy one to deal with at Bukalasa on account of its variation in reaction to soil conditions. Selection work is being carried on and some promising early maturing types have been obtained.

TOBACCO.

The crops at Bukalasa were both complete failures owing to hail and storms. Sufficient selfed seed was, however, obtained from all varieties for next season's crop. The first crop had 100% infection of Mosaic and much leaf-curl before it was ruined.

GINGER.

Again the crop was very late and grew very badly. A preliminary test of ridge cultivation against flat (the local method) indicated a much higher yield from flat cultivation. New varieties were obtained from Sierra Leone and Nigeria and a stock of these is being worked up.

CASSAVA.

The collection of varieties is being augmented by a large number of local types. Work on Mosaic resistance continues and the red leaved variety called Node-wide appears to be the least susceptible of the long-period types. Actually, apart from "Node-wide" and the short period "Bitamisi" variety, all varieties showed 100% infection with Mosaic, but intensity of the disease varied in different varieties.

The most heavily infected were Nakachachali, Nakitembe and Greyhound; the first two of these are the ones most popular with the Baganda.

Palatability tests were carried out and it is fortunate that "Node-wide" proved to be one of the most palatable. Considerable difference of opinion as to the most palatable varieties exists but any definitely unpalatable ones are easily identified.

The 4th-year Agricultural Course from Makerere did a considerable amount of useful work on seed production and Mosaic observations.

ACKNOWLEDGMENTS.

It is a pleasure to record the valuable assistance given by The Liverpool Uganda Company in examining and reporting on samples of lint from the new varieties.

Thanks are also due to Messrs. Narandhas Rajaram & Co., for the assistance they have given in ginning of a number of special samples of Cotton from the Variety trials.

G. W. NYE,
Senior Botanist.

PART IV.—BOTANICAL WORK, SERERE.

METEOROLOGICAL CONDITIONS, 1935-36.

Weather conditions at Serere and in Teso District were such that abnormally high yields were obtained from the early plantings (May and June) while the late plantings gave poor yields.

The total rainfall for the year 1935 was 50.08 inches. This is almost four inches below the fourteen-year mean of 54.02 inches. The heaviest rainfall occurred in May and September. July, one of the critical months for the early plantings, was abnormally dry, consequently Blackarm disease never obtained a firm grip of the plants, and was checked completely during the excessively dry November. One of the most remarkable features of the year was the unusual combination of air temperatures much in excess of the normal associated with sunshine below normal; this applies particularly to the months of June, November and December.

The high yields of the May and June plantings can be attributed to the generally high air temperatures during the day, high rainfall during the planting period, and excessively hot and dry conditions during the boll maturation month, *i.e.*, November.

The low incidence of Blackarm disease was undoubtedly due to the hot days and low rainfall in the two critical months of July and November.

The normal picking months of December, January and February were abnormally wet; in consequence a considerable amount of cotton was severely rain-stained, and some loss of cotton from open bolls must have occurred.

Diseases and Pests.—As already stated above, Blackarm disease was less severe than usual. The accuracy of lesion counts was partially vitiated because a slight hail storm swept over the experimental and breeding plots in August, and the number of lesions per plant was higher than in the previous season because of the mechanical infection.

With the hot and dry conditions these lesions, which were never extensive, soon dried out and caused little damage except to the more susceptible strains.

There was more stain due to *Nematospora* than for some years past, even then one could not consider the damage to be serious. In parts of the Northern Province, however, *Nematospora* caused considerable damage to the late crop.

For more detailed reports on the insect pests the Annual Report of Government Entomologist should be consulted.

SERERE 1935-36 WEATHER CONDITIONS.

Month.	Rainfall.	Sunshine.	Air Temperatures.	Remarks.
1935.				
April ..	Over 2" below average	Above average ..	Slightly above average.	Hotter and drier than normal.
May ..	Over 1" above average	Much below average ..	Below average ..	Wetter and cooler than normal, ideal for cotton planting.
June ..	Over 1" above average	Much below average ..	Above average ..	Wetter and cooler than normal, ideal for cotton planting.
July ..	Over 3" below average	Much above average ..	Much above average ..	Too hot and dry for successful cotton planting.
August ..	Slightly above average	Above average ..	Much above average ..	Rainfall good for cotton planting, but days very hot and sunny.
September ...	$\frac{1}{2}$ " above average ..	Average ..	Above average ..	Rainfall slightly above average but very hot.
October ..	$\frac{1}{2}$ " above average ..	Slightly above average	Above average ..	Rainfall slightly above average but very hot.
November ..	2 $\frac{3}{4}$ " below average ..	Below average ..	Very much above average	Very dry and very hot; resulted in early and rapid maturity of cotton bolls.
December ..	Over $\frac{1}{2}$ " above average	Below average ..	Much above average ..	Some cotton rain-stained but weather still hot.
1936.				
January ..	Over 3 $\frac{1}{2}$ " above average	Just below average ..	Much below average ..	Very wet and cold, large amount of secondary growth; cotton badly rain-stained.
February ..	Over 6" above average	Very much below average	Much below average ..	Very wet and cold, large amount of secondary growth; cotton badly rain-stained.
March ..	Over 2" above average	Average ..	Above average ..	Rainfall irregular distribution; some very hot spells.

THE COTTON BREEDING PLOT.

Following the usual practice at Serere, the cotton breeding plot was planted on July 5th, 1935; and despite adverse weather conditions very good stands were obtained.

Space forbids a detailed account of the behaviour of the different strains, so only an outline of the yields, lint characters, etc., of the more promising strains will be included in this report.

PEDIGREE LINES.

BIOLOGICAL CHARACTERS.

Strain.	Origin.	Parent Strain.	Blackarm Lesions per Plant.		Jassid Nymphs per Plant.	Flowers per Plant.	Bolls per Plant.	Shedding Percentage.
			Total Lesions.	Stem Lesions Only.				
S.P. 90 ..	U. 4/4/2 ..	S.P. 84 ..	0.30	0.01	2.5	61	30	51%
S.P. 92 ..	U. 4/4/2 ..	S.P. 87 ..	0.35	0.01	2.9	51	23	55%
S.P. 93 ..	Nariama ..	S.P. 88 ..	0.31	0.01	1.9	47	19	60%
S.P. 99 ..	U. 4/4/2 ..	S.P. 87 ..	0.25	0.02	1.3	48	19	60%
S.P. 102 ..	S.G. 29 × U. 4 ..	S.P. 89 ..	0.19	Nil	0.8	53	17	68%
B.P. 50 ..	Bukalasa ..	—	1.88	0.12	1.0	43	—	—
Control S.G. 29 ..	—	—	2.46	0.16	1.1	—	—	—

BIOLOGICAL CHARACTERS.

Strain.	Habit.
S.P. 90 ..	Tall but upright. Large bolls. Not very hairy for U. 4/4/2.
S.P. 92 ..	Good. Monopodia very upright. Smallish bolls. Hairy.
S.P. 93 ..	Woody. Dark green leaves. Monopodia strong and upright. Glabrous.
S.P. 99 ..	Fairly compact. Monopodia upright. Fairly hairy.
S.P. 102 ..	Compact. Reminiscent of U. 4 bulk. Very hairy.
B.P. 50 ..	Tall but monopodia very upright. Hairy. Long pointed bolls.

BOLL CHARACTERS.

	Bolls per Plant.	Seed Cotton per Plant. gms.	Lint per Plant. gms.	Ginning Percentage.	Lint Length. mm.
S.P. 90 ..	30	119.5	40.0	33.5	30.7
S.P. 92 ..	23	92.9	32.5	35.0	31.2
S.P. 93 ..	19	77.3	23.0	29.8	31.2
S.P. 99 ..	19	75.5	27.1	35.9	31.1
S.P. 102 ..	17	75.4	23.2	30.8	31.1
B.P. 50 ..	—	69.7	20.6	29.5	—

S.P. 90 gave an extraordinarily high yield although the ginning percentage is lower than the average U. 4/4/2 derivative while the bolls are larger. Its lint length is the shortest of the more promising strains. Selection inside this strain will continue to attempt to remedy the latter defect, and also if possible to increase the ginning outturn.

S.P. 102, derived from a possible cross between S.G. 29 and U. 4, shows U. 4 characters in all respects except quality of lint and ginning percentage. In the latter it resembles S.G. 29.

The Nariama derivative, S.P. 93, gave a satisfactory yield and good lint, but the ginning percentage is too low.

B.P. 50, from Bukalasa while giving very nice lint is too susceptible to Blackarm disease and also gives a low yield and very low ginning percentage.

NEW SELECTIONS.

Seventy-five U. 4 or U. 4/4/2 derivatives, and seventy-four Nyasaland Upland derivatives were planted in the New Selection Series.

The former group was, as usual, the most successful.

After making observations on Blackarm and Jassid susceptibility, forty of the first group were retained and only twenty of the latter group.

One or two of the most promising from each group will be placed in the Pedigree Line Series next season.

TRINIDAD HYBRIDS.

Thirty-two lines selected from a large number of hybrids received from the Empire Cotton Growing Corporations' Trinidad Research Station were planted.

They were extremely disappointing and few, if any, will be carried on to next season. As in previous seasons the best of these lines are derived from the U. 4. by Cambodia cross, back-crossed to U. 4.

SERERE HYBRIDS.

In the previous season a number of crosses were made. This season these first-crosses were planted for observation and back-crossing. The Blackarm resistance and Jassid susceptibility of these F.1's are of interest when compared with their parents. The latter were grown side by side with the crosses.

SERERE F.1's 1935-36.

Number.	Parents. ♂ × ♀	Blackarm Lesions per Plant.		Percentage Plants free from Blackarm.	Jassid Nymphs per Plant.
		Total Lesions.	Stem Lesions only.		
AC.	.. S.P. 13 × N. 17 ..	0.35	Nil	65	2.1
CA.	.. N. 17 × S.P. 13 ..	0.42	Nil	75	2.2
AD.	.. S.P. 13 × S.G. 29 ..	0.56	Nil	64	0.8
DA.	.. S.G. 29 × S.P. 13 ..	0.50	Nil	67	0.3
AE.	.. S.P. 13 × S.G. 23/8 ..	0.42	Nil	71	1.4
EA.	.. S.G. 23/8 × S.P. 13 ..	0.21	Nil	79	0.9
BC.	.. S.P. 80 × N. 17 ..	0.40	Nil	60	3.0
CB.	.. N. 17 × S.P. 80 ..	0.29	Nil	76	2.9
BD.	.. S.P. 80 × S.G. 29 ..	0.41	Nil	59	1.8
DB.	.. S.G. 29 × S.P. 80 ..	0.53	Nil	53	1.6
EB.	.. S.G. 23/8 × S.P. 80 ..	0.38	Nil	69	2.3
CE.	.. N. 17 × S.G. 23/8 ..	1.33	Nil	33	5.7
EC.	.. S.G. 23/8 × N. 17 ..	2.21	Nil	29	5.8
DE.	.. S.G. 29 × S.G. 23/8 ..	1.85	0.08	23	2.2
ED.	.. S.G. 23/8 × S.G. 29 ..	1.53	0.24	7	4.1
CD.	.. N. 17 × S.G. 29 ..	1.43	0.21	32	1.8
DC.	.. S.G. 29 × N. 17 ..	4.82	0.18	Nil	2.0
AB.	.. S.P. 13 × S.P. 80 ..	0.21	Nil	57	1.5
A.	.. S.P. 13	0.18	Nil	86	1.7
B.	.. S.P. 80	0.20	Nil	80	0.7
C.	.. N. 17	2.35	0.09	22	2.2
D.	.. S.G. 29	2.15	0.24	10	1.0
E.	.. S.G. 23/8	1.56	0.04	39	5.2

The Jassid susceptibility of S.G. 23/8 is well shown by the figures for Jassid nymphs per plant of this strain, and also by some of the crosses containing this strain.

S.P. 13 and S.P. 80 are related strains, and both are derived from U. 4/4/2. The first-cross of these two strains gives a lower percentage of plants free from Blackarm disease than either of its parents. The most susceptible to both Blackarm and Jassids are those crosses both of whose parents are Nyasaland Uplands (N. 17, S.G. 29 and S.G. 23/8), while crossing any Nyasaland Upland on to a U. 4/4/2 derivative (either S.P. 13 or S.P. 80) has resulted in good Blackarm resistance—not as good, however, as the U. 4/4/2 uncontaminated with Nyasaland Upland.

The best cross appears to be between S.P. 13 and S.G. 29, and here S.P. 13 is better as the female parent.

The different behaviour of the reciprocals is noteworthy. For example the cross ♂ S.G. 29 × ♀ S.G. 23/8 shows higher resistance to both Jassids and Blackarm than the reverse cross ♂ S.G. 23/8 × ♀ S.G. 29.

The lint characters and ginning percentages of these crosses will be determined.

During the season all the above crosses were back-crossed to both parents. Next season these back-crosses will be planted for further observation and trial.

This method of attack appears to be distinctly promising as a cursory examination of the lint of the first-crosses leads one to believe that the U. 4/4/2 lint characters are readily improved by the addition of some Nyasaland Upland blood. One disappointing result, however, is that the bad plant habit of the Nyasaland Uplands appears to be dominant over the good habit of the U. 4/4/2 derivatives.

MINIATURE VARIETY TRIAL, SERERE.

This experiment consisted of 13 varieties replicated 10 times in random blocks. Each "plot" consisted of one row of 50 plants at 3' x 1' spacing.

The object was to test a number of strains of which insufficient seed was available for inclusion in the larger trials.

It should be noted that comparison of yields are of doubtful significance, owing to the competition of large vegetative strains when grown side by side in single rows with small sympodial strains.

The figures for disease and insect attack are of great interest and the above criticism does not apply. In fact, if Jassids are found to be more numerous on individual rows of any one strain scattered over the experiment, one concludes that these insects have a definite preference for that strain.

The results are included in the following table:—

MINIATURE VARIETY TRIAL, 1935-36, SERERE. VARIETY MEANS.

Variety.	1st Germination. May 31st, 1935.	1st A.L.S. Count. % Plants Attacked.	3rd A.L.S. Count. % Plants Attacked	% Plants with Blackarm Lesions	Final Yield.	Final Yield as Percentage of S.G. 29.
	Blanks.	June 13th, 1935.	July 11th, 1935.	Nov. 16th, 1935.	Lbs. Seed Cotton.	
S.G. 29 ..	5.9	8.2	58.6	83.3	2.601	100
S.P. 89 ..	6.3	4.0	25.2	28.9	3.565	137
S.P. 72 ..	4.7	1.4	13.9	34.6	4.744	182
S.P. 88 ..	9.2	2.7	19.7	38.0	4.776	184
U. 4/4 ..	2.9	1.8	22.5	54.1	4.244	163
S.P. 1 ..	4.1	1.0	11.6	40.8	4.051	156
S.P. 13 ..	4.9	0.6	11.2	34.7	3.625	139
S.P. 20 ..	3.5	1.4	10.9	38.1	3.990	153
S.P. 48 ..	3.1	2.0	9.1	37.1	3.936	151
S.P. 84 ..	7.4	6.0	35.1	42.3	3.960	152
S.P. 56 ..	5.7	7.3	42.2	40.8	3.090	119
S.P. 86 ..	9.4	11.1	45.8	38.1	3.122	120
S.P. 87 ..	9.1	7.0	35.5	45.6	3.618	139
Least significant difference ..	3.1	2.6	9.3	7.5	0.335	13

The outstanding results are:—

- (1) Angular Leaf Spot. (3rd Count). S.G. 29 has higher percentage of plants infected than any other variety.
- (2) Blackarm Lesions. S.G. 29 is more susceptible than any other variety.
- (3) Yield. S.G. 29 has a lower yield than any other variety.

COMBINED VARIETY, SPACING AND SOWING DATE TRIAL, SERERE.

The experiment was conducted on Block D of the Experiment Farm.

Standard plots 27' x 27' were used.

The lay-out was as follows:—

4 x 4 Latin Square for four sowing dates.

Each Sowing Date "cell" of the Latin Square divided into three strips of plots at random for the three spacings 3' x $\frac{1}{2}$ ', 3' x 1' and 3' x 1 $\frac{1}{2}$ '.

The six varieties were scattered at random in each spacing strip.

Thus there were 288 sub-plots in all. The analysis of variance is divided into three parts.

There were 48 replications of each variety irrespective of sowing date or spacing.

The different treatments were as follows:—

Sowing Dates ...	May 1st, 1935.				
	May 31st.				
	July 1st.				
	August 1st.				
Spacing	$3' \times \frac{1}{2}'$.				
	$3' \times 1'$.				
	$3' \times 1\frac{1}{2}'$.				
Varieties	S.G. 29.				
	S.P. 72.				
	S.P. 20.				
	S.P. 43.				
	S.P. 48.				
	S.P. 56.				

The following tables indicate the results after converting actual yields to yields per acre.

VARIETIES (Irrespective of Spacing or Sowing Date).

Varieties.						Total Cotton. Lbs. per Acre.	Least Significant Difference. Lbs. per Acre.
S.G. 29	..	..	..	..	..	705.7	147.3
S.P. 72	..	..	..	..	..	948.8	
S.P. 20	..	..	..	..	..	1,107.1	
S.P. 43	..	..	..	..	..	1,097.1	
S.P. 48	..	..	..	..	..	1,134.5	
S.P. 56	..	..	..	..	..	805.9	

SOWING DATES (Irrespective of Varieties or Spacing).

Sowing Dates.						Total Cotton. Lbs. per Acre.	Least Significant Difference. Lbs. per Acre.
May 1st	..	..	..	..	..	1,156.1	479.8
May 31st	..	..	..	..	..	1,119.5	
July 1st	..	..	..	..	..	1,005.3	
August 1st	..	..	..	..	..	585.1	

SPACINGS (Irrespective of Variety or Sowing Date).

Spacings.						Total Cotton. Lbs. per Acre.	Least Significant Difference. Lbs. per Acre.
$3' \times \frac{1}{2}'$	..	..	..	..	..	961.0	178.2
$3' \times 1'$	..	..	..	..	..	977.5	
$3' \times 1\frac{1}{2}'$	..	..	..	..	..	960.9	

INTERACTION OF SOWING DATE $\times$ SPACING. YIELDS OF COTTON. LBS./ACRE.

		$3' \times \frac{1}{2}'$.	$3' \times 1'$.	$3' \times 1\frac{1}{2}'$.	Least Significant Difference. Lbs. per Acre.
May 1st	..	1,205.1	1,121.3	1,141.8	89.1
May 31st	..	1,065.6	1,127.8	1,165.2	
July 1st	..	958.5	1,071.9	985.4	
August 1st	..	614.9	589.3	551.2	

INTERACTION OF VARIETY $\times$ SOWING DATE. YIELDS OF COTTON. LBS./ACRE.

		May 1st.	May 31st.	July 1st.	August 1st.	Least Significant Difference. Lbs. per Acre.
S.G. 29	..	759.6	819.9	820.7	422.5	63.3
S.P. 72	..	1,098.5	1,164.8	984.1	547.7	
S.P. 20	..	1,279.2	1,280.5	1,162.2	706.3	
S.P. 43	..	1,315.6	1,269.7	1,129.3	673.8	
S.P. 48	..	1,362.4	1,255.4	1,208.6	711.5	
S.P. 56	..	1,121.0	926.9	726.7	448.9	

INTERACTION OF VARIETY $\times$ SOWING DATE $\times$ SPACING.

Space forbids including a table of yields but this interaction is highly significant and the reasons for this will be found under discussion of the results.

DISCUSSION OF RESULTS.

Varieties (Irrespective of Spacing or Sowing Dates):—

- (a) S.P. 20 = S.P. 43 = S.P. 48 $\triangleright$ S.P. 72 $\triangleright$ S.G. 29.
- (b) S.P. 72 = S.P. 56.
- (c) S.P. 56 = S.G. 29.

Sowing Dates (Irrespective of Variety or Spacing):—

- (a) May 1st = May 31st = July 1st.
- (b) May 1st = May 31st $\triangleright$ August 1st.
- (c) July 1st = August 1st.

Spacings (Irrespective of Variety or Sowing Date).—

$$3' \times \frac{1}{2}' = 3' \times 1' = 3' \times 1\frac{1}{2}'.$$

Interaction of Sowing Date $\times$ Spacing:—

- (a) May 1st: $3' \times \frac{1}{2}' = 3' \times 1' = 3' \times 1\frac{1}{2}'$.
- (b) May 31st: $3' \times \frac{1}{2}' \triangleleft 3' \times 1\frac{1}{2}'; 3' \times 1' = 3' \times 1\frac{1}{2}';$
 $3' \times \frac{1}{2}' = 3' \times 1'.$
- (c) July 1st: $3' \times \frac{1}{2}' \triangleleft 3' \times 1'; 3' \times 1' = 3' \times 1\frac{1}{2}';$
 $3' \times \frac{1}{2}' = 3' \times 1\frac{1}{2}'.$
- (d) August 1st: $3' \times \frac{1}{2}' = 3' \times 1' = 3' \times 1\frac{1}{2}'.$
- (e) $3' \times \frac{1}{2}':$ May 1st $\triangleright$ May 31st $\triangleright$ July 1st $\triangleright$ August 1st.
- (f) $3' \times 1':$ May 1st = May 31st = July 1st $\triangleright$ August 1st.
- (g) $3' \times 1\frac{1}{2}':$ May 1st = May 31st = July 1st $\triangleright$ August 1st.

Interaction of Variety $\times$ Sowing Date:—

(a) In all the sowing dates S.P. 43 = S.P. 48; and in all except the first S.P. 20 = S.P. 43 = S.P. 48. In the first sowing date S.P. 20 $\triangleleft$ S.P. 48.

(b) In all sowing dates S.P. 20, S.P. 43 and S.P. 48 are better than S.G. 29, S.P. 72 and S.P. 56.

(c) S.G. 29 $\triangleleft$ S.P. 72 in all the sowing dates.

(d) In the third sowing date S.P. 56 is unduly depressed and is worse than S.G. 29, having been better than S.G. 29 in the first and second. In the fourth it recovers slightly and is equal to S.G. 29.

(e) S.P. 72 equals S.P. 56 in the first sowing date, and is better than S.P. 56 in all subsequent sowing dates.

(f) If the yields of the varieties are plotted against sowing date it is found that the two Nyasaland Upland derivatives, S.G. 29 and S.P. 72, have typical optima curves with yields rising from the first sowing to the second and third sowing dates and dropping off badly to the fourth.

With the U. 4/4/2 derivatives (S.P. 20, S.P. 43, S.P. 48 and S.P. 56) however, yield steadily declines from the first sowing date. It appears, therefore, that the optimum sowing date for these strains is earlier than that of the Nyasaland Uplands.

Interaction of Variety $\times$ Sowing Date $\times$ Spacing:—

The interaction between all three groups of variables is involved, but in general terms it appears that:—

(a) The optimum spacings for the first, second, third and fourth sowing dates are approximately $3' \times \frac{1}{2}'$, $3' \times 1\frac{1}{2}'$, $3' \times 1'$ and $3' \times \frac{1}{2}'$ respectively for all varieties with the exception of S.G. 29.

(b) The optimum spacing for S.G. 29 is the same for all sowing dates, viz: $3' \times 1'$.

(c) Apart from the first sowing date, as sowing date becomes later so the optimum spacing becomes closer; but the reason why the closest spacing is the optimum for the first sowing date is not clear.

LINT YIELDS.

Samples of seed cotton of 2 lbs. each were taken from each variety in each sowing date and ginned on a 12-inch hand gin. The mean ginning percentages of the varieties irrespective of sowing date were:—

S.G. 29	...	...	...	...	32.8%
S.P. 72	...	...	...	...	32.4%
S.P. 20	...	...	...	...	38.5%
S.P. 43	...	...	...	...	40.3%
S.P. 48	...	...	...	...	38.3%
S.P. 56	...	...	...	...	35.8%

The commercial ginning percentages of S.G. 29 and S.P. 20 grown at Serere in the same season were 30.8% and 36.8% respectively. It appears therefore that all samples should have about 2% deducted to bring the ginning outturn down to the commercial level.

For this reason, together with the impossibility of ginning a sample from each of the 288 sub-plots, it was decided that an analysis of variance of lint yields would not be valid using the above figures.

DISTRICT VARIETY TRIALS.

The system of replicating 4×4 Latin Squares of four varieties at different centres scattered over the area East of the Nile was adhered to. Twelve trials were carried out.

The following tables summarise the results:—

TOTAL YIELD.

Mean yield of each variety at each Centre expressed as pounds of seed cotton per acre, together with the Least Significant Difference at each Centre and for the combination of all Centres.

Centre.	S.P. 20.	S.P. 72.	N. 17.	S.G. 29.	Least Significant Difference.
LANGO .. Aduku ..	1,137.5	1,045.2	826.8	791.7	—
Kaberamaido ..	887.9	605.8	531.7	531.7	167.7
Ngetta ..	1,268.8	1,183.0	954.2	868.4	136.5
TESO .. Nyero ..	781.3	716.3	705.9	475.8	72.8
Serere ..	1,276.6	1,342.9	1,146.6	910.0	143.0
BUGWERE .. Kachumbala ..	456.3	469.3	465.4	354.9	—
Kibale ..	847.6	942.5	938.6	858.0	—
BUDAMA .. Mulanda ..	2,124.2	2,206.1	2,122.9	1,703.0	360.1
BUSOGA .. Vukula ..	958.1	790.4	813.8	889.2	—
Bugaya ..	543.4	387.4	457.6	456.3	—
Bulopa ..	479.7	423.8	435.5	449.8	—
Iganga ..	1,479.4	1,227.2	1,250.6	1,196.0	—
General Means	1,020.1	945.0	887.5	790.4	53.8
Mean Yields as percentage of S.G. 29	129.1	119.6	112.3	100.0	6.8

The general mean for all varieties at all centres was 910.75 lbs. per acre. Differences between varieties of more than 5.9% of the general mean show significance.

Conclusions (Combining all centres):—

(a) S.P. 20 significantly higher yield than S.P. 72.

(b) S.P. 72 significantly higher yield than N. 17.

(c) N. 17 significantly higher yield than S.G. 29.

(d) The interaction of Variety × Centre highly significant because:—

(i) N. 17 gave very much higher yields than S.G. 29 in Teso, Bugwere and Budama, while in Lango and Busoga there was little difference between these two varieties.

(ii) S.P. 20 gave much higher yields relative to N. 17 and S.G. 29 in Lango, Teso, Bugwere and Budama than in Busoga.

(iii) S.P. 72 behaved similarly to S.P. 20 except that in Busoga it gave lower yields than both N. 17 and S.G. 29.

QUARTER-ACRE COMPARISONS, EAST OF THE NILE.

As an additional check on the results of the comparison of S.P. 20 *v.* Local in the District Variety Trials described above, thirty-eight pairs of quarter-acre plots were laid down at various Centres scattered over the area East of the Nile, to compare S.P. 20 and Local. In Lango and Busoga the Local variety is N. 17, whilst in the remaining districts it is S.G. 29.

For purposes of comparison, however, the two Locals have been taken as one variety. The results are summarised below:—

MEAN YIELD PER ACRE, LBS. OF SEED COTTON; 1935-36.

Quarter-Acre Comparisons East of the Nile.

District.	No. of Pairs of Plots.	Mean Yield Local.	Mean Yield S.P. 20.	Significance.
Lango	7	689	874	—
Teso	6	551	859	S.P. 20 > Local
Bugwere	7	471	541	—
Bugishu	3	451	676	—
Budama	5	580	607	—
Busoga	10	745	840	—
All centres ..	38	609	751	S.P. 20 >> Local

Combining the 38 Centres, it is found that S.P. 20 has given a significantly higher yield than Local (level of significance P. .01). Lint from certain of these Centres is to be submitted to Messrs. The Liverpool Uganda Company for brokers' opinions.

There were also a further five pairs of plots planted rather late in Chua District of Northern Province. The results of these are not reliable as the native instructors mixed the cotton from the two varieties before it could be weighed.

NORTH TESO VARIETY TRIALS.

In addition to the District Variety Trials three trials were laid down at Katakwi and Toroma in Usuku County and at Kumi in Kumi County. Each trial consisted of 5 randomised block of 3 varieties.

The results (yields per acre of seed cotton) are as follows:—

Centre.	S.G. 29.	S.P. 72.	S.P. 20.	Least Significant Difference.
Toroma	845.5	913.1	1,061.8	—
Katakwi	796.6	905.8	937.0	—
Kumi	545.0	761.3	685.4	119.6
General Means ..	729.0	860.1	894.7	127.9

Conclusions:—

1. Treating centres separately, significance was obtained at Kumi only, where S.P. 20 = S.P. 72 > S.G. 29.

2. Combining all centres S.P. 20 = S.P. 72 > S.G. 29.

It will be noted that the yields per acre on these light soils are extremely high—the highest yet obtained in trials in this area.

ISOLATED PLOT COTTON SOWING DATE TRIAL, SERERE.

As previously stated (*vide* writer's Annual Report for 1934-35), doubts have frequently been expressed as to the validity of Sowing Date trials where the different sowing dates are scattered at random in adjoining plots, because it is argued the earlier sowing attract insects and pests and are liable to infect later sowings. A 6 × 6 Latin Square was laid down with a gap of several yards of virgin bush between each plot.

In the 1934-35 season the whole trial was planted with the variety S.P. 13 and treated as a uniformity trial.

In the 1935-36 season six sowing dates were planted using the same variety.

The results are as follows:—

YIELDS PER ACRE LBS. OF SEED COTTON.

Sowing Date.	Uncorrected Yield.	Yields Corrected from Previous Uniformity Trial by Method of Covariance.
May 15th	908.4	960.3
June 1st	915.3	834.6
June 17th	706.5	843.3
June 29th	690.0	760.9
July 16th	455.0	511.3
August 6th	253.5	324.1
Least significant difference	202.9	19.1

Although the corrected yields give much the same results as the uncorrected, it will be noted that the use of the method of covariance has greatly increased the sensitivity of the experiment; differences of 202.9 lbs. per acre were required to demonstrate significant differences between sowing dates with the uncorrected figures, but by using the method of covariance this figure has been reduced to the remarkably low level of 19.1 lbs. per acre.

The Conclusions are as follows:—

(a) Uncorrected yields:—

May 15th = June 1st > June 17th = June 29th >
July 16th > August 6th.

(b) Corrected yields:—

May 15th > June 1st = June 17th > June 29th >
July 16th > August 6th.

COTTON SEED MULTIPLICATION, SERERE.

QUARTER-ACRE INCREASE STAGE.

The following are the yields obtained from the $\frac{1}{4}$ -acre increase plots:—

Strain.							Yields per Acre. Lbs. Seed Cotton.
S.P. 84	..	..	..	..	..	..	1,141
S.P. 86	..	..	..	..	..	..	854
S.P. 88	..	..	..	..	..	..	756
S.P. 89	..	..	..	..	..	..	960

THREE-ACRE INCREASE STAGE.

In view of the rapid deterioration of S.G. 29 in the previous season, it was decided to run up S.P. 87 in the 3-acre stage directly from the Pedigree Line stage—thus missing out the $\frac{1}{4}$ -acre stage. Great care had to be taken at planting as so little seed was available. One seed per hole was planted, and only two replantings were possible. In all about 14,000 plants were obtained, but even with this very wide spacing the surprising yield of 790 lbs. of seed cotton per acre was obtained. Thus there will be ample seed for the 40-acre stage next season.

40-ACRE STAGE.

The 1935 Farm was planted with the variety S.P. 20. The sowing dates varied from May 16th to June 26th. The Pilot 2-row planter was used.

The total area planted was equivalent to 42.15 acres and this gave an average yield of 863 lbs. of seed cotton per acre over the whole area. The first two blocks, planted on May 16th and 18th, gave yields of 1,168 lbs. and 1,053 lbs. per acre respectively.

These yields are the highest yet obtained over an area of this size on the Serere Farm.

The crop matured very early and picking was completed on January 24th. In the previous year picking continued into February. Much of the cotton was badly stained by the December and January rain.

COTTON SEED MULTIPLICATION, SEGREGATED AREAS.

A. MULONDO AREA.

This was planted up with S.P. 1 grown on the Serere Farm in the previous season.

The monthly plantings were as follows:—

	May.	June.	July.	August.	September.	Total.
Acres	72.8	80.3	59.0	30.9	84.6	327.6

The total acreage in the previous season was 305.2 acres. Owing to very dry conditions during the planting months a large proportion of the crop was planted in August and September—over 35% of the total was planted in these two months—and it is well known that very late planted cotton gives extremely low yields in Teso District.

There was again a shortage of food and the natives living in the area were given assistance by the Agricultural Department. A large area was ploughed up by the Serere ploughs and cattle and late food crops planted. In addition some families received grain from the famine reserve.

B. LABORI—KADUNGURU AREA.

This area was planted with S.G. 29 as in previous seasons.

The monthly plantings were as follows:—

	May.	June.	July.	August.	September.	Total.
Acres	158.9	818.7	1,965.0	713.0	321.4	3,977.0

Here again the August and September plantings were an unduly large part of the whole—26%—due to dry weather. The acreage planted in the previous season was 3,638.0 acres.

C. SERERE—KASILO SAZAS.

Planted with S.G. 29 as in the previous season.

Monthly plantings:—

	May.	June.	July.	August.	September.	October.	Total.
Acres	... 1,167.8	... 5,692.6	... 11,570.0	... 5,352.0	... 3,013.2	... 253.7	... 27,049.3

The proportion of the crop planted after July was as high as 32% of the total.

The previous year's total was 25,314.4 acres.

The buying returns and yields per acre were as follows:—

Area.	Purchases. Lbs. Seed Cotton.			Percentage of Second and Third Quality.	Average Yield per Acre, Lbs. (all Grades).
	1st Quality.	2nd Quality.	3rd Quality.		
Mulondo	95,181	4,356	22,401	21.9	372.2
Labori—Kadunguru ..	943,416	27,269	197,570	19.2	293.8
Serere—Kasilo	8,371,043	376,960	1,142,628	15.4	365.7
Totals and Means ..	9,409,640	408,585	1,362,599	15.8	356.6

The total buyings of nearly 112 lakhs of seed cotton compares very favourably with the 47½ lakhs of the previous season.

The average yield per acre of 356.6 lbs., while not a record, is 21% above the 14-year mean yield of 294 lbs. per acre.

The average prices paid to the growers (excluding the Mulondo Area) for each grade were as follows:—

	1st Quality.	2nd Quality.	3rd Quality.	Total Paid Out. £ Sterling.
Shs. per 100 lbs. seed cotton	8.801	6.472	3.687	£44,768

The number of taxpayers living in the segregated areas is approximately 15,362, consequently the average taxpayer received Shs. 58/28 for his cotton crop.

SPINNING TESTS AND BROKERS' REPORTS.

SHIRLEY INSTITUTE.

Samples from the 1934-35 crop were sent to the Shirley Institute for spinning tests.

Pairs of samples of N. 17 and S.P. 20 were sent from Aduku and Kaberamaido in Lango District and from Vukula and Bulopa in Busoga District.

Pairs of samples of S.G. 29 and S.P. 20 were sent from Kibale in Bugwere and Mulanda in Budama Districts. Also a pair of samples of S.G. 29 and S.P. 56 were sent from Serere. Thus fourteen samples were sent.

The reports are as follows:—

Hair Tests.—"N. 17 is longer and finer than S.P. 20 at Aduku, Kaberamaido and Vukula, but at Bulopa the reverse is the case.

S.G. 29 is longer and finer than S.P. 20 at Kibale and Mulanda: at Serere it is slightly longer than S.P. 56, but otherwise these two samples are very similar to each other.

All the samples are rather immature."

Spinning Tests.—"The results of the spinning tests are on the whole what could be expected from the measured hair characters, the superiority of the N. 17 samples over S.P. 20 being probably due to the lower hair-weights and greater lengths of the N. 17 samples except at Bulopa, where S.P. 20 is the longer and finer and gives the stronger yarns of the two.

Similarly the S.G. 29 samples are longer and finer than S.P. 20, and also give stronger yarns."

In general the N. 17 samples gave lower card room and blow room losses than S.P. 20, while S.G. 29 gave higher losses than S.P. 20 in these two processes.

In yarn appearance all the S.G. 29 samples were classed as poor and very neppy; in this respect S.P. 20 is inferior to N. 17 but superior to S.G. 29.

INDIAN CENTRAL COTTON COMMITTEE.

Four samples from the 1934-35 crop were submitted to the Indian Central Cotton Committee. Unfortunately they considered the sample of S.P. 87 from Serere too small to spin.

The results are as follows:—

GRADER'S REPORT.

	N. 17. Busoga.			S.G. 29. Busoga.		S.P. 20. Busoga.	
Class	Superfine	..	..	Superfine	..	Superfine	..
Colour	Creamy	..	..	Creamy	..	Creamy.	..
Length	1 $\frac{1}{16}$ "	..	..	1 $\frac{1}{16}$ "	..	1 $\frac{1}{16}$ "	..
Strength	Moderate	..	..	Good	..	Very good.	..
Regularity	Regular, somewhat thin and wasty	..	..	Regular	..	Regular.	..
Value above contract rate	Rs. 127 on	..	..	Rs. 130 on	..	Rs. 133 on.	..
Basis	Rs. 208	..	..	Rs. 208	..	Rs. 208.	..
Date	18-1-36	..	..	18-1-36	..	18-1-36.	..

FIBRE PARTICULARS.

	N. 17. Busoga.		S.G. 29. Busoga.		S.P. 20. Busoga.		S.P. 87. Serere.	
Fibre length (inches):								
(a) By Balls Sorter	1.07	..	1.14	..	0.94	..	1.01	..
(b) By Baer Sorter	1.03	..	1.10	..	0.92	..	0.98	..
(c) Weight per inch: (millionths of oz.)	0.112	..	0.108	..	0.131	..	0.135	..

SPINNING TESTS.

	N. 17. Busoga.			S.G. 29. Busoga.		S.P. 20. Busoga.	
Waste Percentages:							
Blow Room Loss	4.7	..	..	5.7	..	3.6	..
Card Room Loss	8.3	..	..	10.2	..	8.6	..
Spinning Loss	0.3	..	..	0.4	..	0.4	..
Total Loss	12.9	..	..	15.6	..	12.4	..
Yarn Strength	2,140 (30.1)	..	..	1,962 (31.2)	..	1,932 (28.5)	..
Lea Test × Count	1,872 (39.0)	..	..	1,799 (39.2)	..	1,675 (39.5)	..
(Actual Counts in brackets)	1,684 (49.1)	..	..	1,582 (49.9)	..	1,495 (50.5)	..
Mean Yarn Strength	1,862	..	..	1,751	..	1,660	..

Conclusions:—

"In spite of its shorter staple, N. 17 gave a better spinning performance than S.G. 29, which in its turn, gave a better performance than S.P. 20, although not to the extent which would be expected from its superior fibre-properties."

1934-35 S.P. 20—SERERE THREE-ACRE INCREASE.

One bale of lint was produced by the 1934-35 three-acre increase of S.P. 20. This was ginned by Messrs. Foster Bros., and then sold to Messrs. Liverpool Uganda Company, Ltd. The latter Company obtained the following spinning report.

REPORT BY MR. PARKINSON (through courtesy of Messrs. Liverpool Uganda Company, Ltd.).

Sample.	Loss at Card. %	Loss in Blowing Room. %	Average Count.	Yarn Strength. Count × Lea Test.
1934-35 S.P. 20 ..	4.60	3.00	44.9	1,650
1933-34 S.G. 29 ..	6.20	6.60	43.4	1,830

It is unfortunate that the control used was from the previous season. The chief point appears to be the low loss both at card and in the blowing room of S.P. 20.

1935-36 S.P. 20—SERERE MAIN CROP.

The twenty-one bales of lint of S.P. 20 grown on Serere Main Farm in 1935-36 was ginned by Messrs. East African Ginneries, Ltd. Messrs. Liverpool Uganda Company, Ltd., sent a full pressed sample of this lint to Liverpool by Air Mail for a report. The following has recently been received:—

“We . . . are attracted by the style of the cotton, though of course the staple is both shorter and weaker than ordinary Teso. . . . in our opinions it is certainly a cotton which should be readily saleable in Lancashire, probably more so than the present cotton (S.G. 29) which is only sold in competition with Egyptian.”

This report taken in conjunction with the high yield of this strain and also its very high ginning percentage—the twenty-one bales ginned out at over 36% under commercial conditions—forces one to the conclusion that it is worth a trial on a large scale for the Liverpool market. It is possible, however, that it would not sell easily on the Bombay market.

BROKERS' REPORTS.

1935-36 Lint samples of nineteen of the more recent strains were submitted to local brokers for their opinions as in the previous year. The consensus of their opinion was:—

1st	...	{	S.P. 89	...	Possible hybrid between S.G. 29 and U. 4.
			S.G. 29	...	Control.
3rd	...		S.P. 84	...	U. 4/4/2 derivative. Outstanding for appearance.
4th	...		S.P. 102	...	Reselection from S.P. 89. Superior in habit to S.P. 89. Good staple but poor in appearance.
5th	...		S.P. 88	...	Nariama derivative.

When compared with last year's list it is found that S.G. 29 has returned to the top—it was not placed last year—also that S.P. 89 and S.P. 84 have retained their positions, while S.P. 87—placed above S.P. 84 last season—has not obtained a place this season. The latter is a disappointing result. The consistency of S.P. 84, however, compensates for the disappointing behaviour of S.P. 87.

GROUNDNUTS.

Breeding Plot.—Thirty-one Spreading type and twenty-one Bunch type selections were planted in 25 plant rows for observation on Rosette disease and analysis of single plant yields.

Two Spreading strains and one Bunch gave particularly promising results. The latter was a reselection from No. 235 (Philippine Pink) which did so well in the previous season.

There was insufficient seed from any of the selections for a variety trial during the season under review. Consequently these strains were increased in small plots. Yields were lower than in the previous season, and it was noticeable that the Spreading types gave higher yields than the Bunch; thus reversing the experience of the previous season.

Four Bunch selections—including No. 235—and four Spreading selections are to be tried against local seed in a small variety trial in 1936. So far we are not in a position to state that selection work has resulted in higher yields.

SHEA NUTS.

Further germination trials were made. It was found that 25% germination can be obtained if the whole fruit (the nut still contained in the green fruit) is planted. No germination was obtained from partly dried nuts or from nuts removed from the fruit and immediately planted.

ELEUSINE CORACANA.

A large number of single plant selections were grown for observation and further selection. The progeny of a number of good plants of several distinct types were bulked for inclusion in a variety trial in 1936.

One-hundred-and-twenty-eight single plant selections were made for the 1936 breeding plot.

SORGHUM.

A collection of the standard varieties of each district is being collected. During the latter part of 1935 twenty-five Teso varieties, twenty-three from Lango, four from Bunyoro and seven from Kenya were grown for observations.

Single plant selections were made as it has been decided to select for good yield of grain for food and also for silage for cattle fodder. One or two varieties were distinctly promising from the latter point of view.

TOBACCO.

In the previous season all the tobacco varieties were smoke cured. This season the same varieties were air cured.

Samples were sent to the Tobacco Officer for his opinion. The latter were not very encouraging, however, as only the Amorello and White Burley samples were considered satisfactory. Selfed seed of a large number of varieties was obtained. There was little disease, but owing to hail much of the leaf was damaged.

SUMMARY.

Extremely high yields of cotton were obtained at Serere and in many of the trials in the districts. The season was one of the best experienced for some years in Teso District.

Once more S.G. 29 has given lower yields than N. 17, despite low Blackarm infection.

In all trials the U. 4/4/2 derivative S.P. 20 has given higher yields than either S.G. 29 or N. 17.

Two strains, S.P. 84 and S.P. 90, have given promising results. The former on account of its extremely high yield.

A series of first crosses between Nyasaland Uplands and U. 4/4/2 derivatives have yielded some instructive, and possibly valuable, results. Back-crossing was done on all the previous season's first-crosses.

Sowing date trials have again demonstrated the value of early planting of cotton.

H. RIVERS HOSKING,

Assistant Botanist.

REPORT ON THE EXPERIMENTAL WORK DONE IN THE NORTHERN PROVINCE, 1935/36.

By T. McEwen, Agricultural Officer.

Experimental work in the Northern Province, which until June, 1935, came under the spheres of influence agriculturally of the Eastern and Western Divisions, is at present largely confined to Ngetta Farm in Lango and to District plots in Lango, Chua and the West Nile. Tobacco seed production for Bunyoro and the West Nile is undertaken at Bulindi in Bunyoro.

The work carried out during the year at Ngetta forms part of the programme laid down in 1933 for the Eastern Division and the present lay-out and organisation of the farm are as described in the Annual Report Part II, 1934.

SECTION I.—COTTON.

MULCHING BY HOEING EXPERIMENT.

Object.—To compare the native practice of leaving the weeds to grow from the beginning of the picking period until the cotton is uprooted and the commonly advocated practice of maintaining a loose hoed surface until later in the season.

Centre.—Ngetta.

Treatments.—(a) Hoed to end of November.

(b) Hoed to end of December.

Sowing Date.—June 13th.

Lay-out.—Five blocks, each containing 2 plots with a random placing of treatments.

Results.—It was found that no weeds grew after the end of November and this probably obscured the results. The yields were:—

(a) Hoed to end of November, 143 lbs.

(b) Hoed to end of December, 147 lbs.

The difference between the yields is not significant.

(This experiment was replicated at Serere and Mbale. The results obtained over the series of experiments are given in the Eastern Division report).

SPACING TRIALS.

Object.—To compare the yields from two spacings.

Centres.—District plots at Aloro, Awelo and Kibuji in Lango.

Treatments.—3 ft. × 1 ft. and 4 ft. × 1 ft.

Lay-out.—Six blocks sub-blocked for spacings.

Results.—Yields of the treatments were:—

<i>Centre.</i>						<i>Yields (in lbs.).</i> 3 ft. × 1 ft.	<i>Yields (in lbs.).</i> 4 ft. × 1 ft.
Aloro ..	..	..	..	..	..	132	121
Awelo ..	..	..	..	..	..	151	161
Kibuji ..	..	..	..	..	..	88	90
Total (all centres)						371	372

There is no significance on analysis of these figures according to Fisher's Method.

VARIETY TRIALS AND QUARTER-ACRE COMPARISONS.

Variety trials to test the relative merits of N. 17, S.G. 29, S.P. 20 and S.P. 72 were carried out during the year at Ngetta, Aduku and Kaberamaido and Quarter-Acre Comparisons, using N. 17 and S.P. 20, at seven centres in Lango.

These trials form part of the variety testing scheme organised from Serere Experiment Station. The yields obtained are given and the results discussed under the appropriate headings in the Assistant Botanist's report on Botanical Work, Serere.

SOWING DATE OBSERVATION PLOTS.

Single plots to obtain observations on the effect of sowing date upon yield in the northern and southern cotton growing tracts respectively of the West Nile were laid down at Aringa and Nebbi and the following yields, expressed in pounds seed cotton per acre, obtained:—

ARINGA.—

Date Sown.	Yield.
June 26th	652
July 20th	804
August 6th	776
August 14th	844
September 6th	640
October 1st	212

NEBBI.—

Date Sown.	Yield.
June 24th	939
July 24th	709
August 24th	574
September 12th	296

The observations from these plots, which bear out results obtained from similar plots grown over a period of years, are that July—August is the best time for sowing cotton at Aringa and that provided the rains arrive in time June sown cotton does best at Nebbi.

SECTION II.—GROUNDNUTS.

An experiment to compare bunch and spreading varieties and to determine the effect of ground cover on yield and Rosette disease was carried out at Ngetta during the year. This experiment forms part of a series carried out at Ngetta, Serere and Mbale.

The results are fully discussed in the Eastern Division report.

SECTION III.—COFFEE.

EFFECT OF SHADE: OBSERVATION PLOTS.

In order to obtain observations on the effect of shade on coffee in the southern highlands area of the West Nile three plots were laid down at Payida in 1932. The treatments were, (a) coffee with no shade, (b) coffee with *Gliricidia maculata* at 6 ft. × 12 ft., and (c) coffee *Leucaena glauca* at 6 ft. × 6 ft. The spacing of the coffee is standard at 6 ft. × 6 ft. throughout. A deep grass mulch was applied at the time of planting and has been maintained subsequently.

The plots came into bearing in 1934. The yields obtained to date, which do not lend themselves to statistical analysis, are as follows:—

Treatment.	Yields (in Lbs. Parchment per Plot).		
	1934.	1935.	Total.
No shade	223.5	436.5	660.0
<i>Gliricidia maculata</i>	205.5	466.0	671.5
<i>Leucaena glauca</i>	198.5	567.5	766.0

Observations indicate clearly that *Leucaena glauca* shade at 6 ft. × 6 ft. and *Gliricidia maculata* at 6 ft. × 12 ft. are both too close under local conditions. A new trial utilising the above shade trees at wider spacings and incorporating certain indigenous shade trees is at present in course of preparation.

SECTION IV.—PASTURES.

Observations on the plots of grasses and pasture plants established at Ngetta in 1933 and subsequently were continued during the year. On the basis of these observations it is now possible to make the following deductions:—

Brachiaria decumbens is more readily established from cuttings than from seed. It produces a good ground cover and a good supply of fodder which is readily eaten by stock. The grass withstands drought noticeably well and, apart from the difficulty of establishing it from seed, is probably the most promising bottom grass tried at Ngetta so far. *Panicum trichocladum*, which at one time gave promise of fulfilling a useful role as the main bottom grass in grass seed mixtures, has been found so liable to rust under Ngetta conditions as to be practically useless. *Cynodon Dactylon* and the very similar *C. plectosachyus* are both readily established from cuttings. Neither is greatly relished by cattle and both tend to spread rapidly to the detriment of better grasses, particularly so under conditions of over-grazing.

Digitaria scalarum and *Hypparrhenia filipendula* are both easily established from cuttings but the former does not appear of much value and the latter does not stand grazing well. Attempts made over three seasons to establish *Pennisetum clandestinum* have failed and it is assumed that either the soil or climatic conditions at Ngetta are unsuitable for this grass.

Pennisetum polystachon is a rapid growing grass not much relished by stock except in the young stage. Its free seeding habit and the rapidity with which it forms a dense cover, however, are useful characters. It possesses the additional advantage that the seed is easily collected. The use of this grass, either *per se* or as the dominant constituent in seed mixtures, can be recommended where the establishment of a dense cover cheaply on resting land rather than the quality of the grazing produced is the primary consideration.

Panicum maximum under Ngetta conditions produces a great bulk of fodder well liked by stock but exhibits the very undesirable character of becoming hummocky and never forming a good soil cover. For this reason its use in pure stand cannot be recommended. This applies particularly to sites on sloping land in any way liable to erosion. *Sporobolus pyramidalis* produces viable seed but is a slow grower, requiring over a year to become established. The herbage produced is somewhat rank. Cattle only eat the tips of the leaves and probably for this reason the herbage shows no tendency to improve under grazing. The chief role of this grass appears to be in mixtures for damp situations in hollows or valley bottoms.

Setaria sphacelata is easily propagated from cuttings but with great difficulty from seed. When established this is undoubtedly the most desirable grass grown so far under Ngetta conditions. It produces an excellent soil cover and plenty of vegetation well liked by cattle. Its principal disadvantage appears to be its susceptibility to ergot.

Medicago sativa when sown under favourable conditions produces a good stand but tends to be crowded out fairly rapidly by indigenous plants. It does not set seed at Ngetta and, after having been tried over a period of three years, does not appear to be of much use under Lango conditions. *Indigofera endecaphylla* is easily grown from seed and tends to spread in pastures. The plant withstands dry conditions very well and produces a small amount of fodder which is readily eaten by stock.

SECTION V.—FERTILITY EXPERIMENTS.

FARMYARD MANURE.

Manuring observation plots put down at Ngetta in 1934 have given the following yields from single plots:—

Plot No.	Treatment.	1934.		1935.	
		Crop.	Yield.	Crop.	Yield.
1	F.y.m.	Cotton	9.5	Wimbi	49
2	No manure (control)		11.0	Wimbi	62
3	Green manure		13.0	Wimbi	74
4	F.y.m.	Groundnuts	35.0	Wimbi	79
5	No manure (control)		25.0	Wimbi	64
6	Green manure		24.0	Wimbi	74
7	F.y.m.	Sweet potatoes	344.0	Wimbi	62
8	No manure (control)		314.0	Wimbi	39
9	Green manure		273.0	Wimbi	65
10	F.y.m.	Sim-sim	2.0	Wimbi	57
11	No manure (control)		1.5	Wimbi	43
12	Green manure		3.0	Wimbi	76
13	F.y.m.	Millet sorghum	62.0	Wimbi	14
14	No manure (control)		57.0	Wimbi	25
15	Green manure		72.0	Wimbi	36

In 1934 the farmyard manure improved on the control plots except in the case of cotton but the effect of green-manure was uncertain. In 1935 the residual effect of green-manure appears to improve upon the control plots in all cases whereas farmyard manure appears to improve upon the control plots only in the case of the index crop following (a) groundnuts, (b) sweet potatoes and (c) sim-sim.

The results, which do not lend themselves to statistical analysis, are inserted as of interest and as indicating a line for a future experiment.

EXHAUSTION EXPERIMENT.

A small plot at Ngetta is being cropped to exhaustion in order to find out how long land will stand up to cropping without manure. The rotation employed is that in common use by the Lango in the vicinity of the farm but does not include the resting period normally allowed in native agricultural practice. The experiment has been proceeding for a number of years and yields are now exhibiting a marked decline.

REGENERATION OF OLD LAND.

One acre of land at Ngetta which had been cropped continuously since 1927 and was reputed exhausted was laid down in 1935 for cropping as follows:—

- (a) Lucerne.
- (b) Grass mixture. Grazed.
- (c) Natural vegetation. Grazed.
- (d) Natural vegetation.
- (e) Grass mixture.
- (f) Clean weeded.
- (g) Sequence of leguminous crop as green manure.

The soil on each strip was sampled at the commencement of the experiment and annually thereafter. Grazing has been carried out where required. The experiment will run for a period of years before the land is again broken up and the fertility of the plots determined by means of an index crop.

T. McEWEN,
Agricultural Officer.

REPORT ON BUKALASA EXPERIMENT STATION FOR THE SEASON 1935/36.

By the Senior Agricultural Officer and the Senior Botanist.

INTRODUCTION.

The work of the Botanical and Agricultural Education Sections carried on at Bukalasa is reported under the Sections concerned.

The general running of the Plantation proceeded as usual. Anti-erosion measures were continued and the lemon grass belts are providing valuable natural terraces.

At the beginning of 1936 that part of the plantation which has been under elephant grass for the last three years was opened up again in order to prepare it for the next season. While no sign of soil wash was observed, there was a considerable amount of lumbugu (*Digitaria scalarum*) in two of the blocks; that lumbugu still persists is probably due to the fact that elephant grass spreads very slowly from a clump and unless the original planting is very close, 2' x 2' or even closer, the ground is not completely covered at the end of three years. It would perhaps be possible to obtain a more complete cover by using seed although the land would have to be cleaner for this purpose than it has to be for cuttings.

The following of native practice in cotton cultivation by less frequent weeding than we used to consider necessary is certainly proving beneficial. The weeds form a mulch and when collected in rows across the slope check erosion; at the same time the amount of root interference is less.

Labour conditions have been somewhat unsatisfactory and the lack of efficient headmen is still serious. No death occurred on the Plantation during the year and the general health of the labour was good. A plague scare occurred at the end of June but despite a number of infected rats being observed no cases occurred.

METEOROLOGY.

Details are given in the Senior Botanist's report and need not be repeated here. The water supply problem was solved by the drilling of a borehole near the stores. Sufficient water is obtainable from this for all normal purposes.

COTTON.

A much lower average yield was obtained due to the fact that a dry July necessitated late planting. Those plots which were early planted yielded well. The proportion of "Fifi" cotton was higher than usual owing to the large amount of rain stained cotton harvested in February.

EXPERIMENTS.

(a) *Interplanting*.—This experiment was similar to that of last season but this time the result showed no significant differences. There was, however, an indication that two rows of beans and two rows of groundnuts between the cotton depressed the yield of the cotton. Actually the interplanting was done too late and judging by native practice the most satisfactory results are obtained by interplanting early sown cotton.

The results are summarised below:—

Treatment.		Yields per Acre.	Yield per Acre.	Yield per Acre.	Cash Income	
		Cotton. Lbs.	Groundnuts. Lbs.	Beans. Lbs.	per Acre.	
					Shs.	Cts.
Control	..	951	—	—	95	10
One row Groundnuts	..	930	285	—	110	10
Two rows Groundnuts	..	885	452	—	115	62
One row Beans	..	880	—	415	104	60
Two rows Beans	..	775	—	608	101	82

Thus all treatments give a better cash return than control.

A test of residual effect in the previous season's experiment was carried out by taking off a crop of groundnuts followed by a crop of cotton. No indication of any residual effect whatsoever occurred in either crop. The cotton yields were very low indeed averaging only 122 lbs. per acre on account of late planting.

(b) *Mulching*.—Mulching for cotton was not repeated as previous results are considered conclusive enough. Mulching late sown cotton is beneficial as not only is a significant increase in yield invariably obtained but in addition the mulch checks erosion and weed growth.

A test of the residual effect of the mulch was carried out on the previous season's plots with groundnuts and cotton as index crops as in the Interplanting Experiment. The result showed no differences at all indicating that the value of the mulch does not extend beyond the crop to which it is applied. A summary of the results obtained in previous years is given below.

FIGURES AS PERCENTAGE OF CONTROL.

Year.	Control.	Mulch.
1930-31	100	131
1931-32	100	274
1932-33	100	100
1933-34	100	119
1934-35	100	144

Mulching has given a significant increase in yield over Control in four years out of the five, and in the odd year gave the same as Control probably because the cotton was planted earlier in that particular year than in the others when it was planted in August.

(c) *Green Manure Experiment*.—This was repeated on similar lines to the previous season. The object of the experiment is to find out if the action of green manure on the subsequent cotton crop is dependent on the length of time that it is dug in before the cotton is planted. Four periods were chosen—2, 4, 6 and 8 weeks before planting the cotton, and in order to ensure that the green manure (*Crotalaria juncea*) was as near as possible at the same stage of growth at each time of digging in it was sown at corresponding dates; the period between sowing the green manure and digging in being approximately six weeks.

Period between digging in and planting Cotton.	Yield Seed Cotton per Acre. Lbs.	Germination Percentage.
Control	798	53.0
2 Weeks	654	36.4
4 Weeks	580	38.7
6 Weeks	726	34.5
8 Weeks	650	34.1
Least Significant Difference	—	4.4%

The yields showed no significance but whereas last season digging in four weeks before planting gave a significant increase in yield over Control, this season there are indications of a reduction in yield. Green manure at all stages depressed germination enormously, all treatments giving significantly lower germination than Control. This is undoubtedly due to the fact that the *Crotalaria* had not rotted owing to the dry weather thereby rendering the soil too open. A residual effect test on the previous season's Experiment with Groundnuts and Cotton as index crops showed no significant differences and it must therefore be presumed that the residual value of the Green Manure was nil.

Two Plants per Hole versus One.

A good stand of two plants per hole was obtained and the resultant yields showed a significant increase in yield due to Two plants per hole. Unfortunately this experiment gave an absurdly low yield and the results cannot be accepted as conclusive.

Treatment.	Yield Seed Cotton. Lbs. per Acre.
One Plant per hole	40
Two Plants per hole	68
Least Significant Difference	10.2

Topping.

A test of the effect of topping at the commencement of flowering gave no significant results. If topping is to be really tested a number of preliminary tests are necessary as its effect must be dependent on planting dates, times of topping and weather conditions. In a very wet year with the plants liable to run to wood topping would probably have a beneficial effect but the correct time to top must be first ascertained.

ROTATION EXPERIMENT.

1. *The Economic Manurial Experiment.*—This experiment was continued the manures being applied to the cotton for the second time. The following rotation is used:—

- 1st year ... Cotton ... Treatment applied.
 2nd year ... Groundnuts ... Residual effect of treatments ascertained.
 Cotton
 3rd year ... Cotton ... Treatment applied.
 4th year as second year and so on.

The three treatments are:—

- (a) Cotton Seed.
 (b) Green Manure.
 (c) Cotton Seed and Green Manure.

The fourth being Control with no manure.

The yields from this experiment were high for the season taking into account the poor nature of the soil. Cotton seed again gave a significant increase in yield over Control and so also did the combination of Cotton Seed and Green Manure. There was no significant increase due to Green Manure alone.

Results:—

<i>Treatments.</i>							<i>Yields of Seed Cotton per Acre.</i>
							<i>Lbs.</i>
Control	..	..	..	..	..	..	890
Cotton Seed	..	..	..	..	..	..	992
Green Manure	..	..	..	..	..	..	911
Cotton Seed plus Green Manure	..	..	..	..	..	..	980
Least Significant Difference	..	..	..	..	..	..	85.2

2. Tobacco Manurial.

The following manures are being tried on a Tobacco Cotton rotation—Cotton Seed, Cotton Seed Ash, and Kraal Manure. These are applied to the Tobacco crop only. No difference in yields of green leaf were obtained. A cotton crop followed and again showed no effect of the manurial treatments.

3. Elephant Grass Rotation Experiment.

To ascertain the length of time necessary for land fallowed under elephant grass to recuperate. Three periods are being tested—2 years, 3 years, and 4 years under elephant grass the control being continuous cropping. The rotation used is one often practised by natives:—

- 1st year ... Cotton (interplanted).
 2nd year ... Food crops.
 Cotton.
 3rd year ... Cotton (interplanted).

The experiment was started this season by taking a crop of cotton over the whole area. A very great variation from plot to plot was shown in the final yields and a chemical analysis plot by plot carried out by the Chemical Section showed no correlation whatsoever between plot yield and chemical constituents. The cropping in 1936-37 will be Groundnuts followed by Cotton. The average yield of Cotton over the whole area of the experiment was at the rate of 308 lbs. per acre.

SWEET POTATOES.

In view of the native preference for hill cultivation and of the fact that ridges are better for stopping erosion, an experiment was laid down to compare the yields from the two methods of cultivation with two local varieties.

No differences were obtained except that the variety "Kaungezi" yielded considerably better than "Kawa". The variety Kaungezi is preferred to Kawa as the latter is very hard.

YIELDS (LBS.). (EACH YIELD IS FOR TOTAL OF 8 1/27 ACRE PLOTS).

				<i>Kawa.</i>	<i>Kaungezi.</i>	<i>Total.</i>
Hill	..	..	..	2,196	4,380	6,576
Ridge	..	..	..	1,794	4,226	6,020
TOTAL	..	..		3,990	8,606	12,596

The main crop of Sweet Potatoes was grown in contour ridges which proved most effective in stopping soil wash. The native objection to ridges probably lies in that the ridges are often not large enough and therefore they do not allow enough room for root expansion. Provided the ridges are large enough there appears to be no obvious reason why they should not yield as well as hills.

GROUNDNUTS.

A *Variety trial* of six varieties was grown in the early rains. The result showed both Bukalasa Bunch and Virginia Bunch Bukalasa to be superior to the remainder. It is almost certain that Bukalasa Bunch and Virginia Bunch Bukalasa are one and the same variety.

The yields were as follows:—

<i>Variety.</i>	<i>Yield in Lbs. Unshelled Nuts per Acre.</i>
Bukalasa Bunch	2,783
Virginia Bunch Bukalasa	2,765
African Bunch	2,003
Philippine Pink	1,913
Virginia Bunch Serere	1,849
Least Significant Difference	290

Increase plots of all varieties were grown.

ROBUSTA COFFEE.

(I) *Shade and Cover Crop Experiment.*

As was anticipated in last season's report a heavy crop was harvested this season. For the first time, however, there were no differences between the various treatments the yields from which are summarised below:—

YIELD EXPRESSED AS LBS. WET CHERRY.

<i>Treatments.</i>	<i>Clean Weeded.</i>	<i>Cover Crop.</i>	<i>Total.</i>
No Shade	4,815	5,013	9,828
Banana Shade	4,837	4,134	8,971
<i>Gliricidia</i> Shade	4,661	5,023	9,684
TOTAL	14,313	14,170	28,483

Each figure represents the yield from $\frac{1}{2}$ Acre.

Although the results are not significant the depressing effect of the combination of Banana Shade and Cover Crop is still evident.

The results obtained for the period 1932-35 are summarised below:—

YIELD OF WET CHERRY EXPRESSED IN LBS. PER ACRE.

	<i>No Shade.</i>	<i>Banana Shade.</i>	<i>Gliricidia Shade.</i>
1932-33	14,825	11,505	13,237
1933-34	30,387	27,320	25,257
1934-35	15,022	15,466	15,958
1932-35	60,234	54,291	54,452

The Least Significant Difference is 4,449 lbs. so that No Shade has given an increase in yield over this period but there is no difference between the other two treatments.

						Clean Weeded.	Cover Crop.
1932-33	..	..	..	..	..	16,889	9,489
1933-34	..	..	..	..	..	27,800	27,509
1934-35	..	..	..	..	..	16,871	14,092
1932-35	..	..	..	..	..	61,560	51,090

The Least Significant Difference is 3,634, thus Clean Weeding has increased the yield significantly compared with Cover Crop.

Treatment.			No Shade.	Banana Shade.	Gliricidia Shade.
Clean Weeding	..	..	66,199	62,553	55,930
Cover Crop	..	..	54,268	46,028	52,974

Least Significant Difference is 6,293, which shows No Shade, Clean Weeding=Banana Shade, Clean Weeding > than all others.

Banana Shade plus Cover Crop < the others.

(II) Ground Treatment Experiment.

The treatments are as follows:—

- (i) Clean Weeding.
- (ii) Mulching with Elephant grass.
- (iii) Permanent Cover Crop.
- (iv) Weed cover (selective weeding).

The Permanent Cover Crop which was originally *Centrosema plumerii* has gradually been naturally replaced by indigenous plants such as *Ipomea* sp. and *Glycine* sp. It is difficult to keep Lumbugu out of the permanent cover plots and constant attention to this weed is necessary. The mulched plots are outstanding in appearance, the coffee plants being a healthy dark green and very vigorous. The Weed Cover plots are also outstanding in the opposite direction as the coffee plants are yellowish and very weakly, producing few primaries and very little crop. The results to date in lbs. of fresh cherry are as follows:—

						1935/36.	Total to Date.
Clean Weeding	..	..	..	..	..	5,428	6,953
Mulching	..	..	..	..	..	5,275	6,850
Cover Crop	..	..	..	..	..	2,076	2,559
Weed Cover	..	..	..	..	..	1,032	1,436
Least Significant Difference	..	..	..	..	..	2,773	—

The figures are totals of 4 plots in each case and represent approximately the produce from $\frac{1}{2}$ acre.

Thus both Clean Weeding and Mulching have for the second year in succession given a significant increase in yield over the other two treatments.

(III) Shade and Ground Treatment Experiment.

No treatments have yet been applied except that half of each plot has received cotton seed as a manure for the last two years. The amount of seed allowed is one petrol tin full per tree.

Very good progress has been made and except for one block on a stony out-crop the coffee is in excellent condition. A good setting of the first crop has occurred and the treatments will commence as soon as this first crop is harvested.

(IV) Shade Demonstration Plots.

Owing to drought conditions, the growth on this plot, which was planted in May, 1934, is very slow. The Shade trees are being planted in the early rains of 1936.

MODEL SHAMBA.

The same tenant was in residence and carried on his cultivation in a very satisfactory manner. He is ably assisted by his wife but it is unfortunate that he is entirely illiterate a matter which makes for much difficulty in the keeping of proper accounts.

The rotation on the economic crop area was altered this year. Previously he had 3 plots under cotton and one under maize but as he already had a spring maize crop and the economic value of maize was small it was decided that the 4th plot should in future be cotton. The rotation now practised therefore is as follows:—

1st ...	Maize.
	Cotton.
2nd ...	Sim-sim.
	Cotton.
3rd ...	Groundnuts.
	Cotton.
4th ...	Green Manure.
	Cotton (interplanted with Beans and Groundnuts).

This addition to the cotton area brings the acreage under cotton up to 2 acres and has undoubtedly been responsible for his large profit. The yield per acre of the various Economic crops were as follows:—

Cotton ...	433 lbs.
Groundnuts ...	1,822 lbs. (highest yield to date).
Maize ...	3,580 lbs.
Sim-sim ...	209 lbs. (highest yield to date).

In addition the coffee came into bearing for the first time and yielded a total of 98 lbs. of sundried cherry.

The income for the season was as follows:—

						Shs.	cts.
Cotton Safi	...	793 lbs.	...	@ 10 cents.	...	79	30
Cotton Fifi	...	50 lbs.	...	@ 4 cents.	...	2	00
Groundnuts	...	850 lbs. (unshelled)	...	@ 5 cents.	...	42	50
Sim-sim	...	209 lbs.	...	@ 6 cents.	...	12	54
Maize (in cob)	...	790 lbs.	...	@ 1½ cents.	...	11	85
Coffee (sundried)	...	98 lbs.	...	@ 6 cents.	...	5	88
Gross Income						154	07
Less 38 man days labour employed @ 33 cents						12	54
Net Income						141	53

His net income of Shs. 141/53 is the second highest since the shamba was started in 1927. (Seed of simsim, maize and groundnuts which were retained for next season's plantings are naturally not included in the statement of income). While results to-date have been entirely satisfactory it should be noted the land is practically flat and not subject to the ordinary processes of surface erosion which necessitate resting periods under grass where small holdings have been established on average sloping land.

OTHER CROPS.

Increase plots of the following crops were grown—*Coronilla varia*, *Glycina javanica*, Soya Beans, Tepary Bean, Madagascar Bean, *Crotalaria* spp., *Phaseolus* spp., *Cassia* spp., *Tephrosia* spp., *Abroma*, etc. The *Coronilla varia* obtained originally from Lyamungu in Tanganyika has spread rapidly and will be tried for coffee in the Shade Demonstration Plot.

EDUCATION.

The usual services have been available for the Educational work.

The 4th and 5th year Makerere students have been in residence most of the period and have received instruction in all the Laboratory, Farm and Experimental work which is proceeding at Bukalasa.

D. STEDMAN DAVIES,
Senior Agricultural Officer.

G. W. NYE,
Senior Botanist.

ANNUAL REPORT ON EXPERIMENTAL WORK DONE IN THE EASTERN PROVINCE, 1935.

By the Senior Agricultural Officer, Jinja.

SECTION 1.—GENERAL.

The organisation of experimental work in the Eastern Province was much the same as in 1934.

Lango District was transferred from the Eastern Province to the administrative division of the Northern Province but the experimental programme at Ngetta Native Administration Farm was continued partly in conjunction with that of the Eastern Province, where the work was carried out at Serere Experiment Station, at the subsidiary farms of Mbale, Wanyange, and Bubulu and in district plots scattered throughout the Province, Bugusege Plantation again being maintained solely in connection with work on Arabica coffee.

1. SERERE EXPERIMENT STATION.

The maintenance of the station in three sections was continued:—

(a) *The Experiment Farm*, consisting of 5 blocks of 10 acres each, cropped under the following rotation:—

1st year	...	...	Cotton experiments, followed by a dressing of manure or compost.
2nd year	...	...	Groundnuts and Millet (<i>Eleusine</i>) experiments. Grass laid down with the late rains.
3rd and 4th years	...	...	Grass (<i>Panicum maximum</i>).
5th year	...	...	Ploughed up and planted with green cover.

(b) *The Old Farm* consisting of 8 blocks of 10 acres, 1 of 6 acres and 1 of 1½ acres. Of the 10 acre blocks, 5 were under grass, 2 were under trees, and one under a regeneration experiment.

The 1½ acre block is laid out with a permanent manurial trial and the 6 acre block is under oil palms.

(c) *The New Seed Farms* comprise 6 blocks of 40 acres each for multiplication of cotton varieties and, if necessary, groundnuts.

To maintain fertility, the aim is to adopt the following rotation as far as possible:—

1st year	...	...	Cotton.
2nd year	...	...	Groundnuts 20 acres, <i>eleusine</i> 20 acres. Laid down to grass during the late rains.
3rd to 5th years	...	...	Grass.
6th year	...	...	Ploughed up and planted with green cover crop.

1934 Farm.—The block opened in 1934 and planted with S.P. 1, yielded 475 lbs. seed cotton per acre in the 1934-35 season, after which it was put down to grass.

1935 Farm.—A second block was opened in 1935 and planted with S.P. 20. In the 1935-36 season it yielded 863 lbs. seed-cotton per acre.

1936 Farm.—A third block will be planted with S.P. 87 cotton in 1936.

The 1937, 1938 and 1939 Farms have not yet been opened up.

2. NGETTA NATIVE ADMINISTRATION FARM.

Of the experiments planted at Ngetta during 1935, those in connection with the Eastern Province programme were as follows:—

- (a) A groundnut mulching and weeding experiment.
- (b) A cotton mulching and late hoeing experiment.

3. WANYANGE NATIVE ADMINISTRATION FARM.

As was foreshadowed in the Annual Report for 1934, work at this farm has been concentrated upon a demonstration small holding. At the same time the experimental plots of Robusta Coffee and observation plots of Oil Palm, Ramie, etc., have been retained.

4. MBALE FARM.

The farm, which is financed by the Bugwere Native Administration, consists of about 30 acres. The experimental blocks are cropped to follow the rotations given in the Annual Report for 1934.

5. BUGUSEGE PLANTATION.

Situated in one of the "low elevation" coffee growing areas of Bugishu District, Bugusege is financed from Protectorate Funds. During 1935 there were about 12 acres under coffee experiments and the remaining land there was cleared for the establishment of further experiments in 1936.

SECTION 2.—GROUNDNUTS.

1. *Variety, Mulching and Weeding Trial.*

(a) *Object.*—The optimum spacing of groundnuts in the Eastern Province is now known and preliminary observations made at Mbale in 1934 indicated a differential effect between weeded and unweeded plots, so the following experiment was laid down to throw further light on this point and to observe the effect of ground cover on Rosette disease as well as on the yields of bunch and spreading types.

(b) *Centres.*—The trial was carried out at Ngetta,
Serere,
Mbale.

(c) *Treatments.*—8.

Varieties. (a) bunch, (b) spreading.

Cultural treatments. I. Grass mulch.

II. Clean weeded.

III. No weeding for first month followed by clean weeding.

IV. No weeding at all.

(d) *Lay-out.*—Five randomised blocks, sub-blocked for varieties with the four cultural treatments randomised within the sub-blocks.

(e) *Results.*

COMBINED YIELDS IN LBS. UNSHELLED NUTS FROM 3 CENTRES.

<i>Treatments.</i>				<i>Total Yield.</i>	<i>Lbs. per Acre.</i>
Varieties	(a) Bunch	..	..	971.1	841.6
	(b) Spreading	..	..	1,609.5	1,394.9
Ground Treatment	I. Grass mulch	..	..	738.8	1,280.6
	II. Clean weeded	..	..	758.8	1,315.3
	III. No weeding for first month followed by clean weeding	..	..	725.0	620.5
	IV. No weeding at all	..	..	358.0	620.5

INTERACTION OF VARIETY × CENTRE. YIELD IN LBS. UNSHELLED NUTS PER ACRE.

<i>Centre.</i>				<i>Bunch.</i>	<i>Spreading.</i>	<i>Centre Means.</i>
Ngetta	..	..	..	902.2	2,563.6	1,732.9
Serere	..	..	..	486.2	689.0	587.6
Mbale	..	..	..	1,136.5	932.1	1,034.3

INTERACTION. TREATMENT × CENTRE.

<i>Centre.</i>				<i>Grass Mulch.</i>	<i>Clean Weeded.</i>	<i>No Weeding for 1st Month.</i>	<i>No Weeding at all.</i>
Ngetta	..	..	..	1,747.2	1,778.4	1,731.6	1,674.4
Serere	..	..	..	910.0	608.4	644.8	187.2
Mbale	..	..	..	1,184.5	1,559.0	1,393.6	Nil

The previous history of bunch *v.* spreading is summarised as follows:—

In 1931, bunch was superior to spreading.

1932, no difference between varieties.

1933, spreading superior to bunch.

1934, bunch superior to spreading.

It will be noted that, as spreading gave superior yields to bunch in 1935, the results over five seasons are conflicting.

(f) *1935 Conclusions.*—Statistical analysis of the figures shows that grass mulch, clean-weeded and no weeding in the first month are all equal to each other but much superior to no weeding at all.

There is a significant interaction between treatment and centre and between variety and centre. Of the latter, spreading was better than bunch at Ngetta and Serere whilst the converse held at Mbale. Regarding treatment and centre, at Ngetta all treatments were equal; at Serere, grass mulch is superior to clean-weeding and no weeding for the first month, the latter in turn being better than no weeding at all; at Mbale, clean weeding and no weeding for the first month are equal but better than grass mulch, as was the case in the preceding season at this centre, and grass mulch is better than no weeding at all.

Rosette counts were made at all centres, but the degree of incidence was too low to demonstrate any difference between varieties.

2. Cotton Interplanted with Groundnuts.

(a) *Object.*—Experimental results at Ngetta and Kaberamaido in the 1934 season favoured interplanting of cotton with bunch groundnuts, with the prices then prevailing for cotton and groundnuts and the experiment was designed to throw further light on the question.

(b) *Treatments and Centres.*— $\frac{1}{4}$ acre observation plots were established at 4 centres in Teso District, Magoro, Wera, Kapiri and Mukongoro in 1935, testing cotton planted at 3' x 1' growing alone, with cotton at the same spacing but interplanted with two rows of bunch groundnuts.

(c) *Results.*—Calculating on the same price basis as in the previous year, results are as follows:—

		Cotton Alone.	Cotton interplanted with Groundnuts.	
			Cotton.	Groundnuts.
Yields in lbs. per acre	..	437 lbs.	406 lbs.	243 lbs.
Price basis	.. ..	Shs. 8/50	Shs. 8/50	Shs. 4/-
Cash value	.. ..	Shs. 37·14	Shs. 34·51	9/72
Total cash return	..	Shs. 37·14	Shs. 44·23	

Thus there was a difference in cash return of Shs. 7/09 in favour of interplanting.

It is indicated that the time of planting groundnuts has important bearing on the question.

SECTION 3.—COTTON.

A. Spacing and Sowing Date.

1. At Mbale Farm.

(a) *Object.*—It was considered that enough data had been obtained regarding cotton spacing, but as confirmation of results previously obtained at Mbale Farm was required, a combined sowing date and spacing trial was laid down there as follows:—

(b) *Treatments.*—Sowing dates 4, May, June, July and August.

Spacings 3, 3' x 18", 3' x 12" and 3' x 6".

(c) *Lay-out.*—Five blocks, sub-blocked for sowing dates with randomised plots for spacing.

(d) *Results.*

YIELDS EXPRESSED AS LBS. SEED COTTON PER ACRE.

Spacings.		Yields.	Sowing Dates.		Yields.
3 ft. x 6 ins. ..	..	1,435.2	May ..	.. ..	1,673.2
3 ft. x 12 ins. ..	..	1,193.4	June ..	.. ..	1,554.1
3 ft. x 18 ins. ..	..	1,276.6	July ..	.. ..	1,052.8
			August	.. ..	426.1

(e) *Conclusions.*—The May and June plantings were equal to one another but very superior to July planting which in turn was superior to August planting.

As to spacings 3' x 6" was definitely superior to 3' x 12" which was equal to 3' x 18" spacing.

No interaction between sowing date and spacing was recorded.

2. *At Serere*.—A further sowing date and spacing experiment was laid down at Serere which included two Nyasaland Upland cottons and four U. 4.4.2 derivatives. This centre is preferable to District Farms for the work at this stage.

3. *Cheptui*.—Observation plots, put down at Cheptui at fortnightly intervals from April to September bore out results of the previous season that early planting in this area is preferable.

B. Cotton Cultural Experiments.

1. Mulching and Hoeing Experiment.

(a) *Object*.—To compare the native practice of leaving the weeds to grow from the beginning of the picking period until hoeing for bulo planting takes place and the advised practice of hoeing until late in the season.

(b) *Treatments*.—2, I. clean weeding to end-November.

II. „ „ „ „ -December.

(c) *Lay-out*.—5 replications of each treatment.

(d) *Centres*.—Serere, Ngetta, and Mbale.

YIELDS IN LBS. COTTON PER ACRE.

Centre.	Weeding to end-December.					Weeding to end-November.		
Ngetta	...	...	...	1,470	...	...	...	1,430
Serere	...	...	...	1,150	...	...	...	1,140
Mbale	...	...	...	2,270	...	...	...	2,240
TOTALS	...	...	...	4,890	...	...	...	4,810

(e) *Conclusions*.—There is no significant difference in the yields either taking each centre separately or taking all three together.

2. Ridging Experiment.—

Cotton and sweet potatoes:—

(a) *Object*.—To compare the effect of ridging and mixed cropping treatments on soil fertility.

(b) *Treatments*.—Ridge and furrow cultivation against flat cultivation.

(c) *Site*.—Serere, Mazimasa, Bukedea, Abela.

(d) *Lay-out*.—At Serere, 10 replications.

at Mazimasa
Bukedea
Abela

5 replications.

(e) *Results*.—Mean yields per acre at the 4 centres were as follows:—

Treatment.	Cotton.					Sweet Potatoes.		
Flat (theoretical)	...	...	...	486 lbs.	...	...	...	8,179 lbs.
Ridges	...	...	...	225 lbs.	...	...	...	8,920 lbs.

(f) *Conclusions*.—As might have been expected, the yield of cotton interplanted with sweet potatoes on the ridge system was reduced, but the figures indicate that the yield of sweet potatoes is less under ridge cultivation per unit area, than under the native method of cultivation.

3. Cotton Cultivation on Mounds and Ridges.

(a) *Object*.—To test the growing of cotton on mounds and ridges against flat cultivation in Usuku County of Teso, where root development is apt to be restricted owing to the nature of the soil.

(b) *Treatments*.

I. Large mounds made from a 4 ft. square, 5 plants per mound.

II. Small „ „ „ „ 3 ft. „ 3 „ „ „

III. Ridges 4 ft. apart, 48 plants per ridge.

IV. Control (flat cultivation) 36 plants per row.

(c) *Site*.—Abela and Toroma, in Usuku.

(d) *Lay-out*.—Six blocks of 4 randomised plots each 36 ft. square.

(e) *Results.*

TOTAL YIELD OF SEED COTTON IN OUNCES.

Centre.		Large Mounds.		Small Mounds.		Ridges.		Control (Flat).
Abela	...	1,731	...	1,394	...	1,617	...	1,400
Toroma	...	1,513	...	1,408	...	1,348	...	1,647
TOTALS	...	3,244	...	2,802	...	2,965	...	3,047

(f) *Conclusions.*—There is no significant difference in yields between treatments, or between treatments and centres.

This is the third year this experiment has been carried out. In 1933 though there was no significant difference, it was indicated that ridges might be better than the other treatments. In 1934, this was confirmed, ridges being significantly better than large mounds which were equal to small mounds and superior to the control.

C. *Variety Trials and $\frac{1}{4}$ -acre Cotton Comparisons.*

In connection with the testing of new varieties of cotton prior to bulk distribution of seed to areas within the Eastern Province, quarter-acre cotton comparison plots were laid down at 43 centres and 12 variety trials established, the yields from which could also be utilised statistically in conjunction with those from the quarter-acre plots.

Further details are given under the Section dealing with Botanical work at Serere.

SECTION 4.—COFFEE.

ARABICA COFFEE.

BUGUSEGE EXPERIMENTS.

1. *Pruning Experiment, 1927.*

(a) *Object.*—To compare the yield obtained from the Single Stem, Multiple Stem and Agobiada pruning systems.

(b) *Lay-out.*—Eight randomised blocks, the sub-plots containing 7 rows of 8 trees spaced at 8 ft. by 8 ft.

(c) *Results.*—Yields in lbs. cherry per treatment over the 7 seasons 1929/30 to 1935/36 inclusive:—

Season.		Single Stem.	Multiple Stem.	Agobiada.	Total.
1929-30	.. ..	740	517	498	1,755
1930-31	.. ..	2,957	3,324	4,455	10,736
1931-32	.. ..	689	823	3,565	5,077
1932-33	.. ..	5,278	6,428	9,065	20,771
1933-34	.. ..	956	4,778	4,287	10,021
1934-35	.. ..	3,593	3,257	6,718	13,568
1935-36	.. ..	1,000	3,866	3,380	8,246
TOTALS ..	..	15,213	22,993	31,968	70,174

Statistical analysis shows that the

Least significant difference between Season Totals is 1,718.

.. Treatment Totals is 2,624.

.. Treatment by Season Totals is 992.

(d) *Conclusions.*—Agobiada is superior to Multiple Stem pruning, which in turn is superior to Single Stem.

A noticeable feature is the marked significance of biennial fluctuation in yields. Yields in the 1932/33 season are superior to all, since when yields in the biennial cycle have dropped off significantly. With the exception of the 1st, 5th and 7th crops, Agobiada has been superior to all others and the cumulative difference is great, in favour of Agobiada. The "Grading Outturn" of Agobiada is inferior, however, to that of single Stem and Multiple Stem and there are indications that there is correlation between "Grading Outturn" and quality.

2. *Pruning Experiment, 1930.*

(a) *Object.*—To test a simple form of multiple stem pruning which may be suitable for natives to use, against natural growth and Agobiada pruning.

(b) *Lay-out*.—Six randomised blocks of 3 plots each. Each plot contains 6 rows of 8 trees at 8 ft. by 8 ft. spacing.

(c) *Results*.—Yields in lbs. cherry per treatment over the 4 seasons 1932/3 to 1935/6 inclusive:—

<i>Season.</i>			<i>Natural Growth.</i>	<i>Agobiada.</i>	<i>Modified Multiple Stem.</i>	<i>Totals.</i>
1932-33	..	..	91	76	168	335
1933-34	..	..	1,344	853	1,927	4,124
1934-35	..	..	615	102	1,188	1,905
1935-36	..	..	1,401	1,293	2,274	4,968
TOTALS ..			3,451	2,324	5,557	11,332

The Least Significant Difference between treatments is 181.

(d) *Conclusions*.—It is too early yet to draw any conclusions from this experiment, but on the above figures the modified multiple stem pruning is superior to natural growth, which in turn is superior to Agobiada.

3. *Cultural Experiment, 1928.*

(a) *Object*.—To compare the yields of coffee maintained under five cultural treatments as follows:—

Clean weeded.

Green manure, 2 covers per annum.

Banana leaf mulch.

Weed cover dug in twice a year.

Leguminous cover crop from October to March and clean weeded for the rest of the year.

(b) *Lay-out*.—A 5 by 5 Latin Square, each sub-plot containing 5 rows of 8 trees spaced 8 ft. by 8 ft. The trees were pruned on the Single Stem system up to 1930, since when they have been allowed unlimited terminal growth.

(c) *Results*.—Yields in lbs. cherry per treatment for the six seasons 1930/31 to 1935/36 are as follows:—

<i>Season.</i>	<i>Clean Weeded.</i>	<i>Two Cover Crops.</i>	<i>Banana Mulch.</i>	<i>Weed Cover.</i>	<i>One * Cover Crop.</i>	<i>Season Totals.</i>
1930-31	.. 947	918	840	1,025	959	4,689
1931-32	.. 2,039	1,575	1,951	1,277	2,025	8,867
1932-33	.. 1,343	1,718	1,977	1,001	2,079	8,118
1933-34	.. 2,789	1,702	1,988	1,909	2,290	10,678
1934-35	.. 1,512	1,168	1,760	592	1,093	6,125
1935-36	.. 1,928	2,245	1,988	1,526	2,555	10,242
TOTALS ..	10,558	9,326	10,504	7,330	11,001	48,719

Least Significant Difference between treatments is 277.

(d) *Conclusions*.—October—March cover crop is superior to both weed-cover and two cover crops a year. Clean weeded, banana leaf mulch and two cover crops a year are also superior to weed-cover, but there are no other significant differences.

Banana leaf mulch and October—March cover crop treatments appear to be the most consistently high yielders.

4. *Cultural Experiment, 1932.*

(a) *Object*.—To compare the yields obtained from coffee under seven different cultural treatments when pruned on a modified multiple stem system.

A. Clean weeded.

B. Green manure—two covers per annum.

C. Banana leaf mulch.

D. Weed cover dug in twice a year.

E. October—March cover crop clean weeded for the rest of the year.

F. March—October cover crop clean weeded for the rest of the year.

(Previously the treatment was banana leaf mulch and stems).

G. *Leucaena glauca* shade, with low hedges of *L. glauca* between the rows slashed back for green manuring.

(b) *Lay-out*.—5 randomised blocks of 7 plots, each plot containing 5 rows of 6 trees at 6 ft. by 6 ft. spacing with 3 ft. paths between plots.

(c) *Results*.—Only two crops have been taken and in the first season the two cover crop treatments and weed-cover gave nil yields.

Total yields per treatment for the two seasons 1934/5 and 1935/6 were as follows:—

A.	B.	C.	D.	E.	F.	G.	TOTAL.
856	341	1,382	143	904	1,705	663	5,994.

The Least Significant Difference between treatment totals is 433.

(d) *Conclusions*.—March—October cover-crop and banana leaf mulch are equal but significantly better than all others. Weed cover is again the worst yielder, as is the case in the 1928 planted cultural experiment.

It is of interest that the March—October cover crop treatment gave such high yields in the 1935/6 season as to draw level with the banana leaf mulch treatment. It is probable that this result is largely due to the effect of the banana leaf mulch and stem treatment previously applied. Further reference to the point is made in the report of the Agricultural Chemist.

5. *Spacing and Pruning Experiment, 1932.*

(a) *Object*.—To determine the optimum spacing in Bugishu for arabica coffee of natural growth as compared with coffee pruned on a multiple stem system.

(b) *Treatments*.—Spacings, 4. 8 ft. by 8 ft.
7 ft. by 7 ft.
6 ft. by 6 ft.
4 ft. by 4 ft.

Prunings, 2. Modified Multiple Stem.
Natural Growth.

(c) *Lay-out*.—Five randomised blocks of eight plots.

(d) *Results*.—Yields in lbs. cherry per treatment for the two seasons 1934/5 and 1935/6, were as follows:—

<i>Pruning.</i>	<i>Season.</i>	<i>8 ft. by 8 ft.</i>	<i>7 ft. by 7 ft.</i>	<i>6 ft. by 6 ft.</i>	<i>4 ft. by 4 ft.</i>	<i>Total.</i>
Natural Growth ..	1934-35 ..	569	651	730	1,674	3,624
	1935-36 ..	1,063	1,229	1,832	2,734	6,858
	TOTAL ..	1,632	1,880	2,562	4,408	10,482
Modified Multiple Stem	1934-35 ..	274	331	737	481	1,823
	1935-36 ..	1,076	1,532	1,714	2,181	6,503
	TOTAL ..	1,350	1,863	2,451	2,662	8,326

Least Significant Difference between spacing totals is 726.

“ “ “ “ pruning totals is 1,027.

“ “ “ “ pruning by spacing is 649.

(e) *Conclusions*.—As regards pruning, natural growth in the first two seasons has given significantly better yields than multiple stem. The behaviour of the spacings within the prunings is, however, different.

Under natural growth conditions 4 ft. by 4 ft. spacing is much superior to 6 ft. by 6 ft., whilst the difference between these spacings with multiple stem trees is not significant. At the wide spacings both types behaved in a similar manner, 8 ft. by 8 ft. being equal to 7 ft. by 7 ft. and both are significantly worse than 6 ft. by 6 ft.

6. *Shade Experiment, 1932.*

(a) *Object*.—To observe the effect of different periods of shade and of permanent shade on the yield of Arabica coffee in Bugishu.

(b) *Treatments*.—Shade is provided by bamboo slats placed on frames raised 9 ft. from the ground over the plots:—

I. Shade removed gradually during a period of one month before flowering, the trees remaining unshaded for one month, after which the shade is gradually returned during the third month.

II. The shade is removed and returned one month earlier than in I.

III. The shade is removed and returned one month earlier than in II.

IV. Permanent shade of the same intensity of I, II, and III.

V. No shade control.

(c) *Lay-out*.—A 5 by 5 Lattin Square.

(d) *Results*.—Total yields in lbs. cherry per treatment for two seasons 1934/5 and 1935/6 inclusive:—

<i>Treatment.</i>							<i>Lbs. Cherry.</i>
I.	...	...	...	...	...	...	508
II.	...	...	...	...	...	...	652
III.	...	...	...	...	...	...	520
IV.	...	...	...	...	...	...	614
V.	...	...	...	...	...	...	619

No differences are significant.

ROBUSTA COFFEE.

In connection with the expansion of coffee growing in Busoga, experimental and demonstration work was continued, and trial plots of Robusta coffee in Bugwere and Budama were maintained. Of the latter, those plots in Bugwere district are a failure.

1. *Shade and Variety Experiment. Wanyange.*

(a) *Object*.—To compare the Erect and the Nganda type of Robusta coffee under Busoga conditions and to observe the effect of shade on both types.

(b) *Treatment*.—*Varieties*. Nganda and Erect types.

Shade. *Gliricidia* shade and no shade.

(c) *Lay-out*.—5 blocks of 4 plots each.

(d) *Results*.—As the experiment was only planted in September, 1934, the trees have not come into bearing, but it has been indicated that *Gliricidia* is not a suitable shade tree under Busoga conditions. Demonstration plots incorporating the above treatments have been maintained at Nawanzu, Nasuti and Kiyunga.

2. *Progeny Rows.*

At Wanyange, observation rows of the Assistant Botanist's selections Nos. 35, 233, 225, 236, 220 and 238 were maintained. An old demonstration coffee block is being used for observing the effect of mulching, cover cropping and clean weeding treatments on Robusta Coffee.

SECTION 5.—OTHER CROPS.

A. TOBACCO.

In order to have information available when the time comes to expand tobacco growing in the Protectorate further trial plots of tobacco of an air curing type were grown at 3 centres in Teso, 3 in Busoga and at two centres in Bugishu, whilst trial plots of a fire-curing type were grown at 3 centres in Busoga and at 2 centres in Bugwere.

The tobacco was planted with the early rains, Amorella being the air curing type used and Blue Pryor the variety for fire-curing.

As to the air-curing type, that from Teso was again reported on somewhat adversely except some from Katakwi, but yields were poor.

In Busoga, yields of about 900 lbs. cured leaf per acre were obtained, but only that from Wanyange, where the leaves were of medium size, received a favourable report.

In Bugishu, yields were fair, and the leaf received a better report than any other sample.

Of the fire-cured type, a yield of 1,100 lbs. cured leaf per acre was obtained at Wanyange and the leaf was reported to compare favourably with similar tobacco grown in Bunyoro and the West Nile.

The Mbale sample was reported to be a very well grown leaf and to be much superior to the autumn grown crop of 1934.

B. CASSAVA.

1. *Cassava Variety Trial.*

(a) *Object.*—To find a variety of cassava suitable as a famine reserve that yields well that is resistant or partially resistant to Mosaic disease and that is palatable.

(b) *Varieties.*—9. Mugowa, Smalling, Brownstick, Bobby Hanson, Nyumbazunga, Bunch of Keys, Numbu, Node Wide and Local Teso.

(c) *Site.*—Serere, Katakwi and Kumi.

(d) *Lay-out.*—4 blocks of 9 varieties. Plots 20' × 16' spacing 4' × 4' giving 20 plants per plot, and each plot surrounded by local variety.

(e) *Time of Planting.*—Serere. November 3rd, 1934. Katakwi and Kumi, early April, 1935.

(f) *Results.*—To date, the results of the Serere trial only are available and statistical analysis will not be made until results at the other two centres are obtained. It is sufficient at this stage to state that the whole trial gave a yield of 6.2 tons per acre after 12 months growth, that the highest yielder, Bobby Hanson, gave 11.3 tons per acre, whilst the lowest, local Teso, gave only 2.4 tons per acre.

Counts showed that the number of Mosaic infected plants ranged from nil to 100%, whilst the highest yielding variety gave the surprisingly high figure of 48% infection.

2. *Wanyange.*

At Wanyange a collection of varieties was maintained, and a new variety called "Mpezazi" was obtained from Amani.

C. OIL PALM.

The oil palms at Serere, planted on 5 acres in 1931 have just flowered. At Wanyange, where there is a 1 acre plot, a number of the trees have borne fruit close to the ground and depredations of animals have prevented accurate yield figures from being obtained.

D. RAMIE.

Small plots were planted at Wanyange, Bubulu, and Serere during 1935. The Wanyange crop planted in June, 1935, was ready for cutting 9 months later and 198 lbs. stripped fibre per acre were obtained.

Generally speaking, growth was rather poor and labour charges were high.

E. MISCELLANEOUS.

A collection of plantains, cover-crops and edible legumes is being grown at Wanyange.

At Mbale, a local bulo crop yielded at the rate of 674 lbs. per acre and the threshing percentage averaged 63%.

F. VETIVER AND LEMON GRASS.

Trial plots were established in Bugishu.

SECTION 6.—FERTILITY EXPERIMENTS.

(A) MANURIAL EXPERIMENTS.

1. *Farmyard Manure.*

(a) *Object.*—To compare the effect of varying amounts of farmyard manure, green manure and green manure with lime as a measure for retention of soil fertility.

(b) *Treatments.*—

Green Manure, *Crotalaria juncea*.

Green Manure and Lime.

Farmyard Manure ... 10 tons.

Farmyard Manure ... 20 tons.

Farmyard Manure ... 30 tons.

(c) *Rotation.*—1st year—Cotton.

2nd year—Bulo (*Eleusine*).

Cotton.

3rd year—Groundnuts.

(d) *Lay-out.*—A 5 by 5 Latin Square.

(e) *Site.*—The experiment was commenced at Serere in 1933. In 1935 the crop planted was groundnuts.

(f) *Results*.—Yields of groundnuts in lbs. of unshelled nuts, and gross returns from each treatment using an arbitrary price basis of 10 cents per lb. for cotton

1 cent ,, ,, ,, bulo
4 cents ,, ,, ,, groundnuts

are as follows:—

<i>Treatment.</i>		<i>Yield in Lbs.</i>		<i>Cash Return, Cents.</i>
Green manure, <i>crotalaria juncea</i>	... ..	1,100	...	3,717·2
Green manure and lime	... ..	1,080	...	3,515·9
Farmyard manure	... ..	1,100	...	4,201·7
Farmyard manure	... ..	1,172	...	4,121·2
Farmyard manure	... ..	1,224	...	4,042·6

(g) *Conclusions*.—No difference between yields of treatments are significant, but if cash returns are considered, the three farmyard manure treatments are significantly better than the lime treatment, though they are not significantly better than the control.

2. Permanent Manurial Trial.

(a) *Object*.—To observe the effect of varying manurial treatments applied over a period of years.

(b) *Site*.—Mbale Farm.

(c) *Treatments*.—There are five treatments in three of which dressings of 10, 20 and 30 cwt. farmyard manure per acre respectively are applied, in the fourth a dressing equivalent to 40 cwt. kraal earth is given and the fifth is a control.

A bulo crop was taken in 1935, but as there was no significant difference in yields between treatments, the figures are not here recorded.

(B) EROSION EXPERIMENTS.

1. Serere Erosion Experiment.

The object of this experiment is to compare the effect of various treatments against ordinary native practice relative to erosion, and a full account appears in the report of the Agricultural Chemist.

(C) REGENERATION OF OLD LAND.

1. Kamuge Regeneration Experiment.

Object.—To compare regeneration of land under cassava against regeneration under grass.

Treatments.—Ten 1/20th acre plots of cassava and ten 1/20th acre plots under grass, mainly Sudan Red Top, were planted in 1934, but the index crop will not be taken until after the cassava has been harvested and the grass ploughed up, in 1937.

2. Serere Regeneration and Break-pan Experiment.

(a) *Object*.—To test the pan-breaking qualities of certain deep-rooted crops and the effect of sub-soiling.

(b) *Lay-out*.—A 5 by 5 Latin Square.

(c) *Site*.—Serere Experiment Station.

(d) *Treatments*.—I. Control—natural weeds.

II. Natural weeds after ploughing with sub-soiling attachment.

III. *Leucaena glauca* planted 3 ft. by 3 ft.

IV. *Tephrosia candida* planted 3 ft. by 3 ft.

V. Indigenous *Indigofera* planted 3 ft. by 3 ft.

The experiment was laid down in May, 1935.

(e) *Results*.—Within a year the *Tephrosia* had made good growth and the *L. glauca* had seeded though only 2 ft. high. The *Indigofera* grew freely and taller than *L. glauca* but without the bushy growth characteristic of the plant in its natural environment.

(D) ROTATION EXPERIMENTS.

Serere Rotation Experiment.—A rotation experiment, testing twelve different rotations, which was started in 1929 at Serere, was brought to a conclusion in 1935 after the experiment had completed its second cycle.

Results.—Using the gross cash returns from each rotation as the criteria of their practical use, three rotations are superior to the rest and those are as follows:—

<i>Year.</i>				<i>1st.</i>			<i>2nd.</i>			<i>3rd.</i>
1929	...	Late	...	Cotton	...	...	Cotton	...	...	Maize.
1930	...	Early	...	Groundnuts	...	...	Maize	...	...	Gr. Manure, Cotton.
		Late	...	Cotton	...	...	Cotton	...	...	—
1931	...	Early	...	Bulo	...	...	Groundnuts	...	...	Sim-sim.
		Late	...	Gr. Manure	...	...	Sim-sim	...	...	Cotton.
1932	...	Early	...	Sim-sim	...	...	Gr. Manure Cotton	...	...	Groundnuts.
		Late	...	Cotton	...	...	—	...	...	Bulo.
1933	...	Early	...	Groundnuts	...	...	Bulo	...	...	Gr. Manure.
		Late	...	Cotton	...	...	Cotton	...	...	Cotton.
1934	...	Early	...	Bulo	...	...	Groundnuts	...	...	Sim-sim.
		Late	...	Gr. Manure	...	...	Sim-sim	...	...	Cotton.
1935	...	Early	...	Sim-sim	...	...	Gr. Manure	...	...	Groundnuts.
Gross return per acre				Shs. 173	...	...	Shs. 148	...	...	Shs. 134.

Conclusions.—It was concluded from the experiment that all the rotations failed to maintain soil fertility.

A. J. KERR,

Acting Senior Agricultural Officer.

Appendix No. 1.

O. 2357/6.

IMPERIAL INSTITUTE,
LONDON, S.W.7.

REPORT ON GERANIUM OIL FROM UGANDA.

The sample of geranium oil which is the subject of this report was forwarded to the Imperial Institute by the Director of Agriculture, and is referred to in his letter No. 2384/350 of the 9th August, 1935.

The oil was stated to have been obtained from *Pelargonium pinnatum*, a plot of which had been propagated from two plants received in 1931 from the Glasnevin Botanical Gardens via Kew. The present sample was the first to be prepared from this plot for report, and a yield of 62 cc. of oil from 68 kilos of fresh leaves was obtained. It was desired to ascertain the quality and market value of the oil.

Results of Examination.

The sample weighed 2 oz. and consisted of a clear, yellowish-brown oil of rather unattractive odour. It was found to have the following constants, which are shown in comparison with those recorded for commercial geranium oils:—

	Present Sample.	Commercial Geranium Oils.	
		Algerian.	Bourbon.
Specific Gravity at 15.5/15.5°C	0.8789	0.892 to 0.904	0.888 to 0.896
Optical Rotation α_D ..	+29.30° at 24°C	—6.5° to —12°	—7.7° to —13.8°
Refractive Index $n_D^{20^\circ}$..	1.4635	1.464 to 1.472	1.461 to 1.468
Acid Value	1.3	1.5 to 9.5	1.5 to 12
Ester Value	126.6	31 to 70	50 to 78
Ester Value after acetylation ..	142.9	203 to 234	206 to 233
Equivalent to "total alcohols" expressed as geraniol), %	44.0	66 to 78	67 to 77.6
Solubility in 70% alcohol at 15.5°C	Insoluble in 12 vols.	Soluble in 2 to 3 vols.	Soluble in 2 to 3 vols.
Solubility in 80% alcohol at 15.5°C	Soluble in 12 vols. with slight turbidity	—	—

The results of examination show that the constants of the present oil differ very considerably from those of commercial geranium oils. The percentage of esters is much higher than usual, while the amount of total alcohols calculated as geraniol is very low. The odour of the oil is weak and not very pleasant and does not resemble that of a geranium oil. Judging from its constants the oil contains an appreciable proportion of terpenes and the presence of geraniol seems rather doubtful. It was not possible however to carry out a more detailed chemical investigation of the oil as the amount available was too small.

Remarks.

The foregoing results show that the oil would be of no value as a geranium oil and it would moreover be unlikely to be of any commercial interest owing to its weak and unattractive odour.

Pelargonium pinnatum is not one of the species usually cultivated for the preparation of the oil and no reference has been found to any previous investigation of the oil. Judging from the results of the examination of the present sample, the cultivation of this species of *Pelargonium* seems unlikely to be remunerative, but before coming to any definite conclusion on this point it would be desirable to examine a further sample of the oil from a later distillation.

29TH NOVEMBER, 1935.

O. 2357/6.

REPORT ON ROSEMARY OIL FROM UGANDA.

The sample of rosemary oil which is the subject of this report was forwarded to the Imperial Institute by the Director of Agriculture, and is referred to in his letter No. 2384/350 of the 9th August, 1935.

The oil was distilled from material derived from a small experimental plot and it was stated that this was the first sample of oil prepared for report. 16 kilos of the fresh stems and leaves yielded 75 cc. of oil. An examination to determine its quality and market value was desired.

Results of Examination.

The sample weighed 2 oz. and consisted of a clear, very pale yellow oil. It was found to have the following constants, which are shown in comparison with those required by the British Pharmacopoeia for rosemary oil and with figures recorded for the principal commercial oils:—

	Present Sample.	British Pharmacopoeia Requirements.	Commercial Rosemary Oils.		
			Dalmatian.	French.	Spanish.
Specific Gravity at 15.5/15.5°C ...	0.9015	0.900 to 0.919	0.894 to 0.913 Seldom under 0.900	0.900 to 0.920	0.898 to 0.920
Optical Rotation, α_D ...	+2.54° at 24°C	—5° to +10°	+0°43' to +5°53'	Up to +13°10' Sometimes slightly negative.	—6° to +11°30'
Refractive Index, n_{D20}° ...	1.4681	1.464 to 1.476	1.466 to 1.468	1.467 to 1.472	1.468 to 1.475
Acid Value ...	0.7	...	Up to 0.7	Up to 1.6	Up to 1.5
Ester Value ...	8.6	...	5 to 20	3 to 14	2.3 to 20
equivalent to esters (expressed as bornyl acetate), per cent.	3.0	Not less than 2	1.8 to 7	1 to 4.9	0.8 to 7
Ester Value after acetylation equivalent to "total alcohols" (expressed as borneol), per cent.	42.4 12.0	...	...	29 to 42 8 to 11.3	30 to 50 8.5 to 14.3
Free alcohols expressed as borneol, per cent.	9.5	Not less than 9	...	...	...
Solubility in 80 per cent. alcohol at 15.5°C.	Soluble in 7 vols. with slight turbidity.	Soluble in 10 vols.	Mostly soluble in 1 to 8 vols.		
Solubility in 90 per cent. alcohol at 15.5°C.	Soluble in 0.2 vols.	Soluble in 1 vol.	Generally soluble in 0.5 vols., sometimes less. Occasionally up to 1 vol.		
British Pharmacopoeia limit test for cineole. Freezing point of Specified mixture.	35.8°C	Not higher	...	...	...

It will be seen that the constants of the present oil comply in every respect with the requirements of the British Pharmacopoeia for rosemary oil and are in agreement with those recorded for commercial oils. The odour of the present oil however was not so pleasant as that of a commercial sample of a pharmaceutical rosemary oil with which it was compared.

Commercial Value.

The oil was submitted to a firm of manufacturing chemists and drug importers in London, who reported as follows:—

"Although the analytical data regarding this oil conforms to the requirements of the British Pharmacopoeia 1932, yet the odour of the oil is not equal to that of the oil produced by French or Spanish distillers. There is a certain harshness—which may, however, disappear on keeping.

"We would place the value of the oil at a little lower than second grade French oil, although, at the same time, we do not think that it is quite equal to Spanish oil. This would make the value about 2s. 3d. per lb. ex wharf London. We would be prepared to give that price for a trial quantity of 1 cwt. to enable us to test the market."

Remarks.

The investigation has shown that this oil has the normal characters of European distilled rosemary oil and would be marketable in the United Kingdom, although its odour is not equal to that of the commercial oils.

With reference to the yield of oil obtained in Uganda, namely, 75 cc. on distilling 16 kilos of the fresh leaves and stems, or 0.42 per cent., it may be mentioned that the material is generally sun-dried before distillation and then yields about 1.20 per cent. of oil.

29TH NOVEMBER, 1935.

IMPERIAL INSTITUTE,
LONDON, S.W.7.

O. 2357/6.

REPORT ON LEMONGRASS OIL FROM UGANDA.

The two samples of lemongrass oil which are the subject of this report were forwarded to the Imperial Institute by the Director of Agriculture, and are referred to in his letter No. 2384/350 of the 9th August, 1935.

The oils were stated to have been prepared from two kinds of lemongrass, "Mityana" and "Kampala", growing on adjacent plots on a Uganda estate, which it had been suggested represent two separate strains of the grass. The "Mityana" strain yielded 50 per cent, more oil than the "Kampala" strain.

It was desired to ascertain whether the oils differ in quality and commercial value.

Results of Examination.

The two samples each consisted of 2 oz. of oil which was somewhat turbid owing to the presence of moisture. After filtration through paper the clear oils were pale brownish-yellow in colour, that from the "Mityana" strain being somewhat paler than that from the "Kampala" strain.

The samples had the following constants, which are shown in comparison with the range of constants obtained for the six samples of lemongrass oil received from Uganda in 1934, and with figures recorded for West Indian lemongrass oil (*Cymbopogon citratus*).

	Present Samples.		Range of Sample received from Uganda in 1934.	West Indian lemongrass Oil (<i>Cymbopogon citratus</i>).
	Kampala Strain.	Mityana Strain.		
Specific Gravity at 15.5/15.5°C ...	0.8816	0.8784	0.8756 to 0.8834	0.870 to 0.912
Optical Rotation α_D ...	-0.09° at 24°C	-0.11° at 24°C	-0.07° to -0.30	-1° to +0.12'
Refractive Index n_{D20}° ...	1.4842	1.4839	1.4835 to 1.4850	1.482 to 1.489
Citral (by bisulphite method) by volume, per cent.	72	72	72 to 79	53 to 83
Citral (by hydroxylamine method) by weight, per cent.	69.0	69.8	71.1 to 77.1	...
Solubility in 80 per cent alcohol at 15.5°C.	Insoluble in 12 vols.	Insoluble in 12 vols.	Insoluble in 12 vols.	Sometimes soluble sometimes insoluble.

* Report of the Essential Oil Sub-Committee to the Standing Committee on Uniformity of Analytical Methods (*Analyst*, 1934, February).

The results of examination show that these two samples of lemongrass oil have similar constants and contain about the same amount of citral. Like the previous samples of lemongrass oil received from Uganda they have the properties of West Indian lemongrass oil (*Cymbopogon citratus*) which possesses a lower specific gravity and has not the ready solubility of Cochin lemongrass oil derived from *C. flexuosus*.

The odours of the samples were very similar and satisfactory, that of the oil from the Mityana strain which furnished the higher yield being considered slightly the pleasanter.

Commercial Value.

The citral content of these oils was rather low in comparison with commercial Cochin lemongrass oils which may contain up to 85 per cent. of citral. Their present value would therefore be somewhat less than 2s. per lb. *c.i.f.*, the price currently quoted for Cochin lemongrass oil, the only lemongrass oil now on the market. Both oils would be readily saleable.

Remarks.

There is no appreciable difference in composition of odour between these two samples, and the oils would be considered as commercially identical. The difference in the yield of oil from plants from the two plots is however of importance, and as the quality of the oils is the same the cultivation of the higher yielding "Mityana" plants in preference to the "Kampala" plants is indicated.

Lemongrass oil is now principally used as a source of citral and the insoluble character of these Uganda oils is therefore of little importance commercially.

29TH NOVEMBER, 1935.

Appendix No. 4.

IMPERIAL INSTITUTE,
LONDON, S.W.7.

O. 2357/5.

REPORT ON GERANIUM OIL FROM UGANDA.

The sample of geranium oil which is the subject of this report was forwarded to the Imperial Institute by the Director of Agriculture, and is referred to in his letter No. 1942/350 of the 27th June, 1935.

The oil was stated to be derived from *Pelargonium Radula* and it was desired to ascertain its quality and commercial value.

Results of Examination.

The sample consisted of 780 cc. of oil which was somewhat turbid owing to the presence of moisture. After filtration through paper the oil was clear and of brownish-green colour.

The filtered oil was found to have the constants shown in the following table, which includes for comparison the results obtained at the Imperial Institute for a previous sample of *Pelargonium Radula* oil from Uganda (see Imperial Institute report dated 22nd December, 1932) and the ranges of corresponding figures recorded for commercial Algerian and Bourbon geranium oils:—

	Present Sample.	Previous Sample (1932)	Recorded figures for commercial geranium oils.	
			Algerian	Bourbon.
Specific Gravity at 15.5/15.5 °C	0.8935	0.8941	0.892 to 0.904	0.888 to 0.896
Optical Rotation α _D	—19.25°	—15.83°	—6.5° to —12°	—7.7° to 13.8°
Refractive Index n _D 20 °C	at 28 °C 1.4694	at 22 °C 1.4718	1.464 to 1.472	1.461 to 1.468
Acid Value	6.9	8.7	1.5 to 9.5	1.5 to 12
Ester Value	20.7	22.5	31 to 70	50 to 78
equivalent to esters (expressed as geranyl tiglate), per cent	8.7	9.5	13 to 29.5	21 to 33
Ester Value after acetylation	211.8	214.2	203 to 234	206 to 233
equivalent to "total alcohols" expressed as geraniol, per cent	69.2	70.2	66 to 78	67 to 77.6
Solubility in 70 per cent alcohol at 15.5 °C	Soluble in 1.7 vols.	Soluble in 1.9 vols.	Soluble in 2 to 3 vols.	Soluble in 2 to 3 vols.

These results show that the constants of the present oil are similar to those of the *P. Radula* oil from Uganda examined in 1932 and resemble those of the Algerian and Bourbon oils of commerce, except that the Uganda oil is more strongly laeverotatory and contains a lower percentage of esters. The odour of the oil is however very inferior to that of the Algerian and Bourbon products and is rather less pleasant than that of the 1932 sample from Uganda.

Commercial Value.

The oil was submitted to two of the firms of importers and both the firms of essential oil distillers in London who reported on the previous sample. The following observations were received:—

Importers.—

(a) "This is a normal Mawah oil, almost identical with that produced in Kenya. There is a good market for this oil at prices varying between 10s. and 14s. per lb. and we should have no difficulty in selling a ton or more a year."

(b) "The oil appears to be similar to the sample which we examined in 1932, and we think that it is a marketable quality. As a matter of fact we ourselves would be interested in having a trial quantity of 100 to 200 kilos, as we think that certain of our customers would most probably be able to utilise this grade of oil. We should estimate the actual value at about 10s. 6d. per lb., landed London. We shall be glad if you will let us know if any plantations have yet been laid out, and also whether there is a likelihood of being able to obtain supplies of this oil in the near future."

Essential Oil Distillers.—

(a) "This is similar to Mawah oil, and has a similar objection in that the odour is slightly mouldy and in consequence the oil would not be a suitable substitute for a

Bourbon or Algerian geranium oil. We would assess its market value at about the same as that of Mawah oil."

(b) "The odour value of this oil is very low. It is coarse and woody, and could not replace for general work the commercial types of Algerian or Bourbon oils. It is also definitely inferior to the Kenya geranium oil which is now offered on the market."

Remarks.

The results recorded above show that this sample of *P. Radula* oil is similar in quality to the sample received from Uganda in 1932, and confirms the general opinion previously expressed as to the market possibilities of the oil. In the trade the oil is regarded as being of similar quality to the Mawah geranium oil produced in Kenya.

The Mawah geranium has been identified as *P. graveolens* Ait. and yields an oil which is distinctly inferior to the commercial Algerian and Bourbon oils, both of which are stated to be derived from *P. graveolens* or a variety of that species. Geranium oil superior to the Mawah oil is however now being produced in Kenya from a variety of *P. Radula* (rosea) received from Kew.

The character of the oil yielded by different species or varieties of pelargonium is known to vary considerably in different countries owing to variations in the local conditions (climate, soil, etc.) and it is consequently necessary to determine experimentally in each country the type of plant which will yield the best quality oil. The results given in the present report show that a marketable geranium oil, although of low quality, can be produced from *P. Radula* in Uganda and it may therefore be decided to develop the cultivation of this species, but it is recommended that experiments be continued with other strains with a view to obtaining an oil of superior quality which will compare more favourably with the Algerian and Bourbon oils and with that produced in Kenya from *P. Radula* (rosea).

In all such experiments the propagation should be effected by cutting only, and the plants not allowed to seed, as pelargonium grown from seed are unlikely to yield oil of the same quality as that obtained from the parent plant.

26TH NOVEMBER, 1935.

Appendix No. 5.

IMPERIAL INSTITUTE,
LONDON, S.W.7.

REPORT ON PATCHOULI OIL FROM UGANDA.

The samples of patchouli oil which are the subject of this report were forwarded to the Imperial Institute by the Director of Agriculture, and are referred to in his letter No. 1942/350 of the 27th June, 1935.

The oils were stated to have been prepared respectively from fresh and fermented leaves, and it was desired to ascertain their quality and commercial value.

Results of Examination.

Both samples as received were slightly turbid owing to the presence of moisture. Sample A, from fresh leaves consisted of 50 cc. of oil which was greenish-brown after filtration through paper, whilst Sample B, from fermented leaves, consisted of 290 cc. of oil which after filtration was rather dark reddish-brown.

The filtered oils were found to have following constants, which are shown in comparison with those of the previous samples of patchouli oil from Uganda which were the subject of Imperial Institute reports of the 7th December, 1931, and 22nd December, 1932, and with the corresponding figures recorded for commercial Singapore and Java patchouli oils:—

	Present Sample.		Previous Samples from Uganda.		Figures recorded for oils from	
	A From fresh leaves.	B. From fermented leaves.	1931.	1932.	Singapore.	Java.
Specific Gravity at 15.5/15.5°C.	0.9673	0.9688	0.9443	0.9271	0.960 to 0.985	0.925 to 0.935
Optical Rotation α_D ...	—52.79° at 29°C	—52.14° at —27°C	—12.6° at 21°C	—1.3° at 21°C	45° to —65° 1.5080 to 1.5120	†3° to —33° 1.5000 to 1.5080
Refractive Index n _D 20°C.	1.5090	1.5090	1.5043	1.5021	1.5120	1.5080
Acid Value ...	1.4	1.4	...	0.3	...	...
Ester Value ...	3.1	3.7	...	5.8	1.5 to 7	6 to 20
Solubility in 90 per cent alcohol at 15.5°C.	Slightly turbid with 10 vols., and not entirely soluble in 15 vols.	Soluble in 9 vols. with slight turbidity.	Slightly turbid with 7 vols. Not entirely soluble in 10 vols.	Soluble in 7 vols.	Usually soluble in 3 to 10 vols. Some oils in 1 vol. or less.	Soluble in up to 10 vols., sometimes with turbidity.

These results show that the two present samples had almost identical constants, which, however, differed from those of the Uganda patchouli oil examined in 1931 and 1932. The latter agreed with the figures recorded for normal Java patchouli oil derived from *Pogostemon Heyneanus*, whereas the present results correspond with those of Singapore patchouli oil derived from *P. patchouli*, except that the solubility of the oils is inferior to that of Singapore oils of good quality. In this connection it would be of interest to learn whether the present samples were derived from the same stock of plants as the earlier samples, or whether a new supply of plants has been introduced.

The samples were superior in odour to the Uganda oils previously examined, the oil from fermented leaves having decidedly the stronger and better odour of the two.

Commercial Value.

The oils were submitted to one of the firms of importers and both firms of essential oil distillers in London who reported on the previous sample dealt with in Imperial Institute report of the 22nd December, 1932. The following observations were received from these firms:—

Importers.—

“These two samples we find inferior to either the Singapore or the Seychelles oils, and we value them to-day at about 4s. 6d. to 5s. per lb. Of the two oils we prefer the one distilled from fermented leaves.”

This firm expressed the opinion that as there are adequate supplies of patchouli oil on the market it would be unwise to recommend the commercial production in Uganda of these oils, especially as the samples are inferior in quality to the oils from existing sources of supply.

Essential Oil Distillers.—

(a) “The present samples show a great improvement on those submitted in 1932, probably due to improved methods of distillation. The specific gravity and optical rotation of the old sample were very low, whereas the present samples are normal. The sample from fresh leaves has a poor odour and would not find a ready market, but the sample from fermented leaves is good and compares very favourably with the Singapore and Seychelles oils.”

(b) “These oils were compared for odour value against English oil of our own distillation and imported Singapore patchouli oil. The oil marked “A” from fresh leaves possessed no odour value worth noting. That of “B” had a strong woody note. It is inferior to the Singapore oil and much inferior to the English. The oil “A” has no market value in our opinion. “B” is worth about 70 per cent. of foreign oil, which to-day is marketed at about 10s. to 11s. per lb.”

In connection with the foregoing commercial reports, it may be mentioned that supplies of Singapore patchouli oil are currently realising 10s. 3d. to 10s. 6d. per lb. spot in London, and that Seychelles oil is being offered at 6s. 6d. to 6s. 10½d. per lb. c.i.f.

Remarks.

The results of the present investigation show that these two samples of patchouli oil, and especially that distilled from fermented leaves, are definitely superior in quality to the oils previously received from Uganda and more closely resemble the Singapore oil of commerce. Oil of the quality of the sample obtained from the fermented leaves (Sample B) would probably be saleable in the United Kingdom in competition with the lower and less soluble grades of Singapore patchouli oil and with the Seychelles product. Oil of the quality of that obtained from the fresh leaves (Sample A) would not be readily saleable.

The quality of the Uganda oil would be improved if the solubility in alcohol could be increased. In distillation experiments carried out at the Imperial Institute with dried fermented and unfermented patchouli leaves from Seychelles (*see Bulletin of the Imperial Institute*, Vol. XXVII, 1929, p. 289) it was found that the later fractions of the oil were less soluble than the first fractions. On the other hand, experiments carried out by Holdsworth-Haines in Seychelles (*see Bulletin of the Imperial Institute*, Vol. XXVII, 1934, p. 553) indicated that “the soluble portions of the oil are those which distil towards the end of the distillation, emphasising the importance of quality is to be considered of completely exhausting the leaf under process. Furthermore the importance of bulking all the oil from a given distillation must not be overlooked.”

In view of these divergent results it would be of interest if experiments could be made in Uganda to determine the relative solubility of the earlier and later fractions of oil obtained in distilling the leaves, as such experiments may supply data which would indicate means of obtaining oils of greater solubility for export.

O. 2357/5.

IMPERIAL INSTITUTE,
LONDON, S.W.7.

REPORT ON VETIVER OIL FROM UGANDA

The sample of vetiver oil which is the subject of this report was forwarded for examination to the Imperial Institute by the Director of Agriculture, and is referred to in his letter No. 1942/350 of the 27th June, 1935.

Results of Examination.

The sample consisted of 11 cc. of a viscous, somewhat turbid oil. After filtration through paper the oil was still slightly turbid and brownish-yellow in colour.

The quantity of oil was not sufficient for chemical examination but the physical constants of the oil were determined with the following results, which are shown in comparison with those recorded for the commercial oil distilled in Europe from imported vetiver roots and for that distilled in Reunion:—

	<i>Present Sample.</i>	<i>Figures recorded for Commercial Vetiver Oil distilled in</i>	
		<i>Europe.</i>	<i>Reunion.</i>
Specific Gravity at 15.5/15.5°C	1.0126	1.014 to 1.040	0.980 to 1.020
Optical Rotation α_D .. +37° (approx.) at 27°C		+25° to +38°	+15° to +37°
Refractive Index $n_D 20^\circ\text{C}$..	1.5232	1.5210 to 1.5270	1.5150 to 1.5280

It will be seen that the three constants of the present sample which were determined agree with those of the commercial vetiver oil distilled in Reunion.

The sample had a very satisfactory aroma, which was similar to, but not quite so persistent, as that of the oils distilled at the Imperial Institute from samples of dried vetiver roots received from Uganda (*see* Imperial Institute reports of the 9th June, 1931, and 9th June, 1933).

Commercial Value.

The oil was submitted to two firms of essential oil distillers in London, who furnished the following observations respectively:—

(a) "This is a very good oil and has a very fine orris-like odour. If the oil from large-scale production is up to this quality it should find a ready market."

(b) "This oil possessed a fair odour value, though it is definitely inferior to the average commercial Bourbon vetiver oil. We think it might be valued at about 60 per cent. of the Bourbon oil, which is offered to-day at about 42s. per lb."

Remarks.

The results of this investigation confirm those previously obtained with the oils distilled at the Imperial Institute from samples of vetiver root from Uganda and show that oil of satisfactory quality can be produced from roots grown in the Protectorate. Oil of the quality of the present sample would find a market in the United Kingdom at a price approaching that of Bourbon vetiver oil.

It would be of interest to learn the percentage of oil which was obtained in Uganda in the distillation of the roots furnishing the present sample, as in view of the comparatively small yield obtained at the Imperial Institute from Uganda vetiver roots (1.2 and 1.6 per cent. respectively) it appeared doubtful whether the production of the oil in Uganda would be remunerative. As mentioned in Imperial Institute report of the 9th June, 1931, samples of vetiver root from various parts of the Empire previously examined at the Imperial Institute have furnished up to 3.3 per cent. of oil, when the roots were distilled until practically the whole of the oil was extracted. In Java the industrial yield is stated to vary from 2 to 3 per cent., and a yield of 4 per cent. has been obtained by increasing the time of distillation beyond the economical limit, *i.e.*, when the value of the oil distilling over no longer pays for the cost of the distillation.

26TH NOVEMBER, 1935.

Appendix No. 7.

D. 744/2.

IMPERIAL INSTITUTE,
LONDON, S.W.7.REPORT ON *CHENOPODIUM* OILS FROM UGANDA.

The two samples of oil which are the subject of this report were forwarded to the Imperial Institute by the Director of Agriculture and are referred to in his letter No. 1555/350 of the 30th May, 1935.

One of the oils was stated to be derived from *Chenopodium ambrosioides* (a variety of which, *C. ambrosioides* var. *anthelminticum*, yields the American wormseed oil of commerce), and the other from *Chenopodium Botrys*, the leaves of which are used by natives in Uganda as a medicine.

Results of Examination.

The samples each weighed 4 oz. That labelled *C. ambrosioides* was a clear brownish-yellow oil, whilst the *C. Botrys* oil was dark yellowish-brown. The oils were examined in accordance with the requirements of the British Pharmacopoeia (1932) for wormseed oil, and the following results were obtained:—

	<i>C. ambrosioides.</i>	<i>C. Botrys.</i>	Requirements of British Pharmacopoeia.
Specific Gravity at 15.5/15.5°C	0.9179	0.9531	0.960 to 0.980
Optical Rotation α_D ..	+0.25° at 24°C	Too dark to obtain reading	4° to —8°
Refractive Index n_D^{20} ..	1.4800	1.4995	0.474 to 1.479
Heat Test	Continued to boil for some seconds after removal from the flame and left after cooling a rather dark brown liquid.	Did not continue to boil after removal from the flame.	Continues to boil vigorously for some seconds after removal from the flame and leaves after cooling a deep golden-yellow liquid.
Ascaridole, % by weight ..	40.7	Nil	Not less than 65
Solubility in 70% alcohol ..	Insoluble in 15 vols.	Insoluble in 15 vols.	Soluble in 3 to 10 vols.

These results show that the present sample of *C. ambrosioides* oil contains a much lower percentage of ascaridole than that prescribed by the British Pharmacopoeia and that in other respects it fails to conform with the requirements. Such oil could not be marketed in the United Kingdom for medicinal purposes. The percentage of ascaridole might possibly be increased by modifying the conditions of distillation, and it is suggested that a further trial might be made using the procedure recommended in the United States. The oil obtained from a distillation carried out on these lines might be forwarded for comparison with the present sample.

The oil *Chenopodium Botrys* differs widely from American wormseed oil and contains no ascaridole. This oil would find no outlet in European medicine, and owing to its dark colour, somewhat sticky nature, and unattractive odour, it would be of little, if any, value in perfumery. It seems unlikely to be of commercial interest.

A sample of oil stated to be that of *C. Botrys* was examined in 1932 in the Soviet Union by W. Issajeff, who obtained it from plants growing in Tajikistan. This investigator found the following constants:—

Specific Gravity at 20°	...	...	...	...	0.908
Optical Rotation	...	...	...	...	$\times 0^\circ, 10'$
Refractive Index n_D^{20}	...	...	...	...	1.4910
Ester Value	...	...	...	...	22.8

The Tajikistan oil is stated to have contained 5 per cent. of aldehydes and ketones, and 1 per cent. of phenols. No mention is made of the presence of ascaridole, which was presumably absent. Examination of the present sample of *C. Botrys* oil from Uganda showed it to contain only 1 per cent. of aldehydes and/or ketones as determined by the bisulphite method, and about 1 per cent. of phenols.

8TH AUGUST, 1935.

Appendix No. 8.

IMPERIAL INSTITUTE,
LONDON, S.W.7.

REPORT ON *ABROMA AUGUSTA* FIBRE FROM UGANDA.

The samples of fibre which are the subject of this report were forwarded to the Imperial Institute by the Director of Agriculture, and are referred to in his letter No. 1943/350 of the 27th June, 1935.

The plants from which the fibres were prepared had been grown from seed obtained from the Belgian Congo.

Description.

The samples weighed about $\frac{1}{4}$ lb. each, and were as follows:—

No. 1. "Chemically retted".

This sample consisted of clean, rather harsh, imperfectly separated fibrous ribbons, of greyish-brown colour. The material was rather lifeless in appearance and had a somewhat "soapy" handle.

The length of the ribbons varied from about 6 to 10 feet, being mostly from 7 to 8 feet. The strength of the separated fine fibre was irregular, but on the whole good.

No. 2. "4 days water-retting".

This material was in the form of clean, but imperfectly separated, fairly lustrous ribbons, varying in colour from pale cream to buff. Some of the ribbons were rather hard and gummy in places and could not be readily separated into single strands of fibre.

The length of the ribbons varied from about 6 to 10 feet, being mostly from 7 to 8 feet. The strength of the separated fine fibre was variable, but on the whole similar to that of jute of good quality.

No. 3. "6 days water-retting".

This was a sample of clean, soft, fibrous ribbons, well prepared and separated and mostly of very pale cream colour.

The length of the fibre varied from 4 to 10 feet, being mostly from 6 to 8 feet. The strength was similar to that of the above sample retted for 4 days.

Results of Examination.

The cleanest of the three materials, *i.e.*, the fibre retted for 6 days, was selected for chemical examination, and the results are given in the following table in comparison with the corresponding figures previously obtained at the Imperial Institute for the fibre of young *Abroma augusta* plants grown in India and for commercial Indian jute of "Extra Fine" quality:—

				Present Sample. %	Indian <i>Abroma Fibre</i> . %	Indian Jute. %
Expressed on the moisture-free fibre	Moisture	..	..	9.8	11.8	9.6
	Ash	..	..	0.6	0.6	0.7
	a-Hydrolysis, loss	..	..	8.6	7.7	9.1
	b-Hydrolysis, loss	..	..	13.0	13.9	13.1
	Water-washing, loss	..	..	2.3	—	—
	Cellulose	..	..	76.9	78.0	77.7

The above results show that the analytical figures of the Uganda fibre retted for 6 days are in agreement with those previously obtained for *A. augusta* fibre from India. The percentage of cellulose and the losses on hydrolysis in the present sample are satisfactory. The composition of the fibre is in general similar to that of jute of good quality and the material would probably be equal to the latter in durability.

Commercial Value.

The three samples were submitted to merchants in London, who reported on them as follows:—

“No. 1. *Chemically retted*.—About 9 ft. long, brownish in colour, strength irregular, fibres adhering together through method of treatment. We judge that the chemical method of treating this fibre is a failure, as the fibre in this form would have very small value, *viz.*, nominally £12 to £13 per ton.

“No. 2. *4-days water-retting*.—About 9 ft. in length, whitish in colour, bark adhering at the branches of the plant, good average strength, inclined to be brittle. Value £16 to £17 per ton.

“No. 3. *6-days water-retting*.—This is the best specimen of the three, very well treated without having lost any strength, of exceptionally good colour and more soft and spinnable than the other varieties. Value £18 to £20 per ton.

“It is difficult to place a value on this fibre, as it is not quite suitable to substitute for jute and has not the characteristics of *Crotalaria*, and it is not strong enough and is too brittle to be classed amongst the hard fibres, such as Manila, Sisal and New Zealand hemp.

“In conclusion, we would suggest that a consignment of 10 tons be sent over so that it could be sold to a mill for experimental purposes in order to ascertain its practical value.”

At the time of the above valuation jute was quoted as follows:—Jute “Firsts”, August—September (New Crop), £19 5s. 0d. per ton *c.i.f.*, United Kingdom.

Remarks.

Of the three samples submitted, No. 3, prepared by retting for 6 days, is the best.

Sample No. 1, which had been chemically retted, was of poor colour, harsh and imperfectly separated. Fibre of this quality would not be readily saleable and would realise a relatively low price. This sample was found to be slightly alkaline and it would thus appear that after chemical treatment the material had not been sufficiently washed: it is therefore possible that with more careful preparation a fibre of better appearance would be obtained. It may however be mentioned that as a rule efficient water-retting yields a product of superior appearance and quality to that obtained by chemical retting.

The other two samples, prepared by retting in water, were of better quality, the fibre prepared by 6 days' retting being superior to that retted for 4 days.

Abroma augusta fibre would be classed as a “soft” fibre, and its commercial utilisation would depend upon its suitability for spinning as a substitute for jute. Sample No. 3 shows promise as a spinnable fibre and is of better colour than jute with equality in strength, but it would be advisable to ascertain its behaviour on jute-spinning machinery before making a decision on its commercial prospects. For this purpose a small consignment, as suggested by the merchants to whom the samples were submitted would be necessary. As the quantity mentioned by them, *viz.*, 10 tons, may not be obtainable the Imperial Institute would be glad to learn what amount of fibre is likely to be available in the near future, with a view to arranging trials on a smaller scale.
